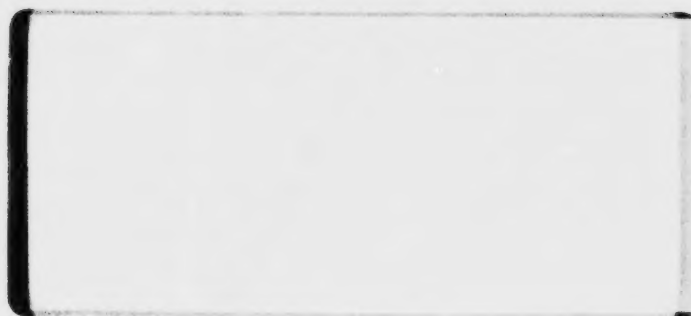




Petro-Canada Products

**RESEARCH AND DEVELOPMENT CENTRE
SHERIDAN PARK, ONTARIO, CANADA**

IMPACT OF NITROGEN COMPOUNDS ON
THE PROCESSING OF SYNTHETIC GAS OIL

Final Report

by

J. Chmielowiec

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TECHNICAL STAFF CONTRIBUTIONS

Microreactor tests were performed by R.K. Lennox and J. Chmielowiec. B.B. Galvez and R.R. Deutscher were responsible for performing pilot reactor tests. R.K. Lennox and M.J. Giampuzzi prepared denitrogenated- and model-feeds, respectively. J.G. Spiro supplied computer program for reporting microreactor test results and M.J. Giampuzzi processed hydrocracking data. Analytical services were supplied by L.W. Beauchamp, J.E. Coffey, J. Thomson and M.H. Vandal. J. Chmielowiec was Project Manager for this program and handled the overall interpretation of the results obtained.

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1. SUMMARY

The effect of nitrogen components on the hydrocracking of Syncrude gas oil was studied.

The gas oil was denitrogenated by solvent extraction with dimethyl sulfoxide based media. Model feeds, prepared by doping the denitrogenated oil with model nitrogen compounds, were used to characterize activity of Ni/W catalyst. The hydrocracking experiments were performed using bench-scale microreactors, while product evaluation tests were carried out using pilot-plant scale reactors.

Conversion of syncrude gas oil was found to be dependent on the total nitrogen content. Most of the types of the nitrogen functional group influenced product characteristics to a small extent.

An enhancement of hydrocracking yields was observed for the denitrogenated gas oil feedstocks. Middle distillates of higher cetane number and low aromatic naphthas were produced from these feeds. Evidence on the inhibition of cracking- and aromatic ring saturation- reactions by nitrogen components is discussed.

2. INTRODUCTION

2.1 Objective

The overall objective of this project was to assess catalyst performance and the extent of changes in product yields and quality due to the presence of nitrogen species in hydrocracked gas oils.

The specific objectives were as follows:

- to derive background information on the relationship between hydrocracking of Syncrude gas oil and its total nitrogen content;
- to evaluate whether types of N- functionality influence catalyst activity and product yields;
- to assess effectiveness of several denitrogenation procedures.

2.2 Justification

One use of synthetic crude oils derived from nonconventional sources will be in the production of liquid transportation fuels. At present these oils are available as refinery feedstocks in small quantities. These alternate feeds are heavier, more aromatic, may be higher in metals, sulfur, and nitrogen. In comparison to conventional refining, additional processing will be needed for economic processing of the new feeds. Hydrodenitrogenation and catalyst deactivation by nitrogen poisoning appear to be particularly important.

There is only limited information available about a role of nitrogen constituents in hydrocracking of the Syncrude gas oil. This research study was undertaken to determine how the catalyst activity and hydrocracking yields are affected by the presence of nitrogen compounds of different types.

2.3 Hydrocracking of Syncrude Gas Oil

In response to the penetration of synthetic crude into the Canadian crude supply several synthetic crude-specific units have been installed in refineries (Gulf Edmonton, Shell Scotford, Esso Strathcona). These were developed using conventional petroleum relationships and extensions of existing technology. Synthetic crudes, commercially produced at Syncrude Canada Ltd. and Suncor Inc. tar sands projects, have specific characteristics that make them unique. These include a high aromaticity and low sulfur content. Analyses of the gas oil fraction of the synthetic crude* oil have also revealed high contents of NH type species and higher ratios of pyrrolic nitrogen to basic nitrogen in comparison to conventional gas oils (1).

This study addresses possible relationships between the processing of the Syncrude gas oil (SGO) and its nitrogen constituents.

The processing of the Syncrude gas oil for direct conversion to usable transportation fuel by hydrocracking was investigated by the Research and Development Department of Gulf Canada (2). Recently, the commercial production yields obtained from dual purpose hydrotreater/hydrocracking unit onstream in Gulf Canada's Edmonton Refinery have been published (3). The work reported herein addresses specifically: catalyst deactivation, hydrodenitrogenation and yield improvements.

2.4 Background - Literature Review

With respect to catalytic processing of distillates nitrogen compounds are not desirable. A review of the literature shows nitrogen compounds adversely affect catalyst activity, processability and product quality.

2.4.1 Deactivation of Catalysts

Heterogeneous catalysts lose some activity over time through poisoning, fouling, thermal degradation, and catalyst loss (agglomeration, fragmentation, vapour emissions, etc.). Catalyst deactivation and some mechanisms for the retardation and prevention have been recently reviewed by Bartholomew (4) and Hughes (5).

*Produced by hydro processing of fluid coked bitumen (Syncrude, Alberta).

Two basic mechanisms of the chemical deactivation may be differentiated. These are impurity poisoning and self-poisoning. The latter type comprises fouling by coke i.e. deactivation by substrates, intermediates and/or products acting as coke precursors. Hegedus and McCabe (6) discussed several types of impurity poisoning. The following chemically induced changes were identified:

- inhibition caused by the competitive, reversible adsorption of the poison precursor;
- poisoning due to the irreversible adsorption, deposition, or reaction involving a poison precursor and the catalyst surface;
- restructuring of the catalyst surface;
- pore plugging.

Catalyst poisons influence selectivity of active catalyst sites. Three types of intrinsic processes are reported to depict poisoning selectivity (4). These are:

- a selective poisoning that initially poisons the most active sites;
- a nonselective poisoning that reduces catalyst activity in proportion to the amount of poison;
- an antiselective poisoning that initially poisons the least active sites.

Catalyst chemical deactivation is inevitable, however, some of its consequences can be avoided or delayed (33). In contrast to fouling with coke, which may be reversed by gasification of carbon deposits, irreversible chemical changes cannot be cured. They, however, can be prevented or retarded by processing selected crudes, pretreating distillates and manipulating mass-transfer regimes to minimize the effect of carbon or coke on activity. Carbon deposition can deactivate both the cracking (acidic) and hydrogenation sites on bifunctional hydrocracking catalysts. The latter are particularly vulnerable as regeneration via carbon combustion rarely returns the catalyst to the original activity level.

There are grounds to believe that nitrogen compounds present in various feeds retard the rate of catalytic reactions due to adsorption on active surface sites. A good correlation has been

reported between the number of zeolite hydroxyls and amount of pyridine used for poisoning of cumene cracking activity in the absence of Lewis sites (7). This observation was extended for 2,6-dimethylpyridine that permitted selective poisoning of Bronsted sites of synthetic zeolite 'Y' (8). Ammonia prepoisoning of the acidic function on both fresh and spent hydrocracking catalysts was found to be effective for selectively studying their hydrogenation function (9).

Studies performed in the forties and fifties revealed the susceptibility of cracking catalysts to inhibition by nitrogen compounds (10-12). Ammonia and organic nitrogen compounds were found to decrease the overall conversion and gasoline yield at a constant coke yield. The nitrogen compounds diminished the cracking activity of the catalyst to varying degrees.

Recently, the effect of nitrogen compounds on the cracking of a gas oil has been demonstrated using modern cracking catalysts (13). It was found that nitrogen compounds are not equally harmful to catalyst surface. A molecule's gas phase proton affinities were used to explain how poisoning depends on the structure of the nitrogen compound. Under conditions favourable to hydrodenitrogenation, an inhibition of olefin hydrogenation by nitrogen compounds has been reported (14). In contrast, under conditions unfavourable to hydrodenitrogenation, nitrogen compounds acted as inhibitors of hydrodesulfurization by reversible poisoning the catalyst (15).

2.4.2 Hydrodenitrogenation

Hydrodenitrogenation (HDN) is the catalytic process by which an organic nitrogen compound is converted to hydrocarbons and ammonia in the presence of hydrogen. In petroleum refining applications, HDN catalysis is performed at temperatures ranging from 350 to 420°C and pressures involving several thousand psi of hydrogen. Heterogeneous catalysts: (Ni-Mo, Co-Mo and Ni-W) are usually employed. The nitrogen removal as ammonia is effected both to remove potential poisons for downstream refinery catalysts and to render resultant fuel products more environmentally acceptable (NO_x emissions).

Model compound studies of various heterocyclic nitrogen compounds have shown that HDN proceeds via saturation (hydrogenation) of the ring followed by hydrogenolysis of C-N bonds first to open the

heteroring and then to convert the resulting aliphatic or aromatic amine intermediates to hydrocarbons and ammonia. Under HDN reaction conditions, hydrogenolysis of C-N bonds is essentially irreversible, but saturation of heterocyclic rings is potentially reversible depending on the temperature and hydrogen partial pressure (16). The reaction networks studied for five-membered heterocyclics represented by indole (17) and six-membered heterocyclics typified by pyridine and quinoline (18) revealed that C-N bond breakage rather than ring hydrogenation is rate determining.

A comparison of the relative rates of heteroatom removal from model N-, S- and O-compounds and of hydrogenation of polynuclear aromatics points out high reactivity of nitrogen compounds. The following ordering of reactivity by chemical type was found by Rollmann (19): sulfides >> p-alkylphenols > benzothiophenes > quinoline, O-alkylphenols, indoles, benzofurans, naphthalenes > dibenzofurans >> mononuclear aromatics. The ordering reported for the catalytic removal of S, O and N from heavy gas oil was different. Furimsky (20) concluded that relative rates of 'hydrodeheteroatomization' are in qualitative agreement with the C-S, C-N and C-O bond strengths i.e. hydrodesulfurization reactions are the fastest and are followed by HDN (slower) and hydrodeoxygenation (the slowest).

The faster hydrodenitrogenation of pyrrole than pyridine was observed (21). They were ascribed to faster denitrogenations of five-membered ring heterocyclics than six-membered ones structure due to ring connectivity affecting as primary factor the electronic structures of the species undergoing the catalytic reactions (22). Other researchers, however, reported that the rate of HDN appeared to depend strongly on the steric characteristics of N-compounds i.e. some markedly slower HDNs were ascribed to the steric hindrance effect (23). Extensive research on hydrotreating shale oil has shown different susceptibility of nitrogen compound types to HDN. Basic nitrogen compounds were found to be more extensively hydrodenitrogenated by an active nickel-tungsten catalyst than were non-basic nitrogen compounds (24). In subsequent study Holmes and Thompson (25) have reported on the susceptibilities of HDN of specific nitrogen compound classes. The sequence of least difficult to most difficult was as follows: amide types, less hindered alkylpyridine types, pyrrole types, and hindered alkyl-pyridine types. However, other researchers revealed that

differences in severity of hydrotreating conditions affect relative HDN reactivities of nitrogen containing compounds (26). For instance, HDN of pyridine types was faster than pyrrole types at lower temperature and pressure but the converse occurred at more severe temperatures $>440^{\circ}\text{C}$ and pressures >13.8 MPa. The discrimination tendency towards HDN was also concluded from analyses of nitrogen constituents of a coker gas oil and its hydrotreated products (27). Nitrogen bases with a low degree of aromaticity appeared to be relatively resistant comparing to higher benzologues, while the relative effectiveness of removal of carbazoles and benzocarbazoles was influenced by temperature and partial pressure of hydrogen.

Under HDN reaction conditions organosulfur- and organooxygen-compounds present in materials derived from petroleum seem to affect HDN reactions. The effect of H_2S and water vapour (products of hydrodesulfurization and hydrodeoxygenation respectively) was studied by Satterfield and coworkers. H_2S had a slight inhibiting effect on the HDN of quinoline and a marked enhancing effect on hydrocracking reactions, so the net effect was an enhancement of the overall rate of nitrogen removal (28). The rate of the overall pyridine HDN was also enhanced by thiophene (H_2S under those conditions) (29). On the contrary, water vapour moderately accelerated and inhibited certain reactions, so there was little net effect on the overall HDN rate at 330 and 375°C and a slight inhibiting effect at 420°C .

Hydrocracking catalysts used for the upgrading of feeds abundant in nitrogen are not equally effective in HDN and equally deactivated by nitrogen compounds. The catalysts, such as Co-Mo, Ni-W and Ni-Mo on alumina or silica-alumina (amorphous or zeolitic), appear to offer the most desirable characteristics for cracking, hydrogenation, hydrodesulfurization in concert with HDN. A comparison of shale gas oil denitrogenation reactions over Co-Mo and Ni-W catalyst pointed out the latter as more effective for removal of basic nitrogen, while the former was more effective for removal of pyrrolic nitrogen at higher denitrogenation levels (30). A screening of catalysts at 410°C and 3.0 h^{-1} LHSV indicated that catalyst containing Ni-Mo were superior for coal liquids HDN (31).

The order of HDN activity was found to be Ni-Mo $>$ Co-Mo $>$ Ni-W, while carbazoles were more difficult to remove than other

nitrogen compounds with Ni-Mo/Al catalyst. Recently, a study of catalytic hydrocracking of heavy gas oil (N content = 5600 ppm) has selected Ni-Mo/Al as the best for HDN out of Ni-W/Al and Co-Mo/Al (32). As far as cracking, hydrogenation and hydrodesulfurization performance at high nitrogen content was concerned, the Ni-W/Al was the best.

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3. EXPERIMENTAL

3.1 Feeds

Syncrude gas oil (SGO) obtained from Gulf Canada's Edmonton Refinery and Suncor coker gas oil (SCGO) obtained from Alberta Research Council were employed in this study. Two-stage extractions carried out on both feeds yielded denitrogenated gas oils - DSGO and DSCGO, respectively. Table 1 compiles properties and compositional characteristics of both raw gas oils and their denitrogenated raffinates.

Model feeds were prepared by adding a toluene or acetone solution of individual organic nitrogen compounds to DSGO and distilling off solvent. Then, the microreactor feeds were filtered through Millipore 5A° filters to remove any remaining suspended solids and analyzed for the total nitrogen content (see Table 2).

TABLE 1

Inspections of Feeds				
	SGO	DSGO	SCGO	DSCGO
Density, kg/m ³ @ 15°C	0.9334	0.9295	0.9584	0.9490
Viscosity, cSt, 40°C	29.048	29.461	24.125	24.388
Viscosity cSt, 100°C	4.318	3.923	3.919	3.834
Sulfur, ppm w/w	1500	1200	34 200	33 300
Total Nitrogen, ppm w/w	963	246	1934	662
Basic Nitrogen, ppm w/w	200	<2	739	252
NH Nitrogen, ppmN W/W***	521	119	592	184
Total Aromatics*, mass %				
Monoaromatics	41.72	40.48	29.10	27.93
Diaromatics	9.60	7.50	13.50	12.11
PNA	6.22	5.06	12.70	9.77
Gas Chromatographic Distillation, °C				
IBP	205	236	125	213
10%	289	297	286	296
20%	321	326	311	319
30%	344	346	331	338
40%	362	363	349	356
50%	378	379	368	374
60%	396	398	387	393
70%	417	418	408	414
80%	441	442	432	438
90%	473	474	464	468
FBP	572	573	555	556
Fractionation, wt %				
IBP-360°C	33.5	31.2		
360°C+	65.9	67.7		
Composition**, mass %				
	360°C-	360°C+	360°C-	360°C+
Paraffins	9.63	5.53	5.68	6.72
Cycloparaffins	37.15	35.03	43.82	37.83
Aromatics	53.22	51.52	50.5	51.13

* Assessed from molar absorptivities at UV range

** Mass spectrometric analysis

*** NH measured at 3480 cm⁻¹ (pyrrolic functionality) using carbazole as a calibration standard.

TABLE 2

Model Feeds in Order of Running*

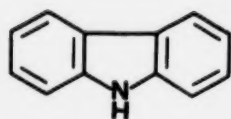
<u>Number Assigned</u>	<u>Compound Type</u>	<u>Nitrogen Component</u>	<u>Total Nitrogen Content of Feed**</u> ppm
		Carbazole***	449
1	Primary amine	Octadecylamine	1027
2	Aromatic base	Acridine	922
3	Ternary amine	N-Ethylcarbazole	894
4	Sec. amine	N-Phenylnaphthylamine	830
5	Aromatic base	Diphenyl-4-pyridylmethane	827
6	Amine	2-Aminoanthracene	255
7A	Aromatic base	Diphenyl-2-pyridylmethane	943
8A	Aromatic base	Phenanthridine	950
9	Pyrrolic	2-Phenylindole	631
10	Pyrrolic	Carbazole	427
8B	Aromatic base	Phenanthridine	950
7B	Aromatic base	Diphenyl-2-pyridylmethane	472

* Hydrocracking data in the Appendix

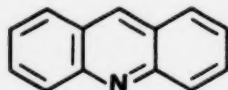
** DSGO contained 246 ppm of nitrogen prior to the addition of model compound.

*** Catalyst required longer deeding. Test repeated (see No. 10)

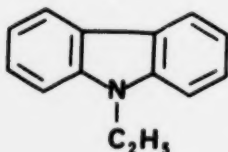
TABLE 2 (Continued)



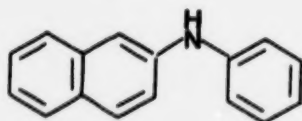
CARBAZOLE



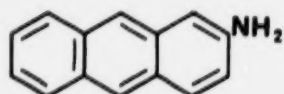
ACRIDINE



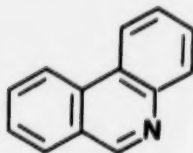
N-ETHYLCARBAZOLE



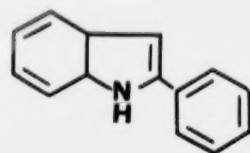
N-PHENYLNAPHTHYLAMINE



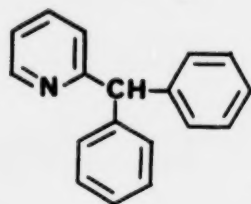
2-AMINOANTHRACENE



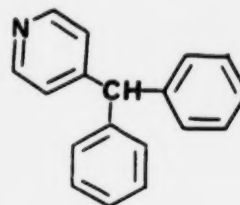
PHENANTHRIDINE



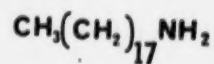
2-PHENYLINDOLE



DIPHENYL-2-PYRIDYLMETHANE



DIPHENYL-4-PYRIDYLMETHANE



OCTADECYLAMINE

3.2 Denitrogenation

3.2.1 HCl-loaded sorbent

Anhydrous hydrogen chloride adsorbed on a catalyst surface was tried for reducing the nitrogen content of SGO. Prior to denitrogenation, the gas oil was dehydrated by passing over molecular sieves at 100°C. Then the gas oil was pumped upflow over the sorbent (HCl-loaded Super DX catalyst from the Davidson Chemical, Maryland) at LHSV ranging from 0.25 to 0.45 h⁻¹. The sorbent was prepared as described by Audeh (Ind. Eng. Chem. Prod. Res. Dev. 22 (1983) 276). In a typical experiment 1 kg of the sorbent was calcined in a glass reactor at 400°C+ in a stream of argon for 16 h or longer. Neither calcination temperatures up to 590°C nor calcination time up to 48 h influenced the denitrogenation.

The one-, two- and three-stage treatment yielded denitrogenated effluents containing 177 ppm, 64 ppm and 7.2 ppm of nitrogen, respectively. However, it was observed that denitrogenation efficiency began to decrease significantly with increasing oil/adsorbent volume ratio from 0.2 to 4. In addition, it was found that the nitrogen removal was accompanied by strong adsorption of the highest molecular weight components of the gas oil. For instance, in the experiment employing 1 kg of the sorbent and 4 L of the stock, approximately 19% of the material was removed. Based on the above results, the denitrogenation of SGO by means of the adsorption was found to be ineffective and an alternate denitrogenation method was applied.

3.2.2 Extractions with dimethyl sulfoxide

Following a two-stage extraction the nitrogen content of 40 L of Syncrude Gas Oil was reduced from 962 to 246 ppm w/w as nitrogen. The compositions of the extracting media were similar to those tested in DSS contract 15SQ.23440-3-9059. The procedure used for denitrogenating SGO was as follows:

Equal volumes of SGO and dimethyl sulfoxide (DMSO) containing 6% of H₂O were shaken for 2 h and left to disengage overnight. The raffinate was then extracted, shaken for 2 h with an equal volume of DMSO containing 6% of 5N H₂SO₄ and left to disengage overnight. Then, the second stage raffinate was

washed twice with equal volumes of water and dehydrated by distilling off entrained water at 160°C and approximately 100 kPa vacuum (at 160°C all residual DMSO was expected to be removed).

The first stage extracting solution removed 2.43% of the feed, while the second stage treatment removed only 1.23% of the 1st stage raffinate. Results of several extraction experiments performed prior to selecting the second stage extracting medium are shown in Table 3.

TABLE 3

DMSO Acid Extractions

<u>Sample</u>	<u>Total Nitrogen</u>
Syncrude Gas Oil	962
<u>1st Stage Raffinates</u>	
(A) DMSO containing 6% H ₂ O	451
(B) DMSO containing 6% 5N H ₂ SO ₄	392
(C) DMSO containing 6% 5N HCl	368
<u>2nd Stage Raffinates (from raffinate 'A')</u>	
DMSO containing 6% H ₂ O	358
5N HCl	394
DMSO containing 6% 1N HCl	243
DMSO containing 6% 5N HCl	235
DMSO containing 6% 10N HCl	271
DMSO containing 6% 5N H ₂ SO ₄	249

3.3 Catalysts

Two types of the catalysts were employed in this program. The zeolite catalyst was prepared by American Cyanamid Co., Research Laboratories in Stamford, Conn. The LZ-Y72 molecular sieves (Union Carbide) based catalyst was an extrudate with size 1/16". The Harshaw Ni-4301E catalyst sample was supplied by the Harshaw/Filtrol Partnership, Elyria, Ohio. The latter catalyst was used both in the microreactor and pilot reactor tests. The extrudates with size 1/12" were used in the latter tests, while the microreactor tests employed ground, sized to 0.6-1 mm and then presulfided particles. The inspected properties of the catalysts are shown in Table 4.

TABLE 4
Catalyst Inspection

<u>Properties</u>	<u>Zeolite</u>	<u>Harshaw Ni 4301E</u>
Ni, wt %	5.7	5.1
W, wt %	23.1	19.0
SiO ₂ , wt %	41.7	54.6
Al ₂ O ₃ , wt %	25.1	8.7
Crush strength, lbs	16.6	17.0
Bulk Density, g/cc	0.92	0.89
Surface area, m ² /g	290	230
Pore volume, cc/g	0.14	0.37
Size	1/16"	1/12"

The sulphiding of the catalysts was carried out over a 48-hour period according to a standard procedure, which is outlined as follows:

- The reactor was charged with sieved and dried catalyst in the arrangement specified for normal charge.
- The reactor was warmed up to 149°C and H₂ was circulated to dry the catalyst until no water was apparent in the line traps following a final leak check.

- Syncrude middle distillate was used as the presulphiding feed and was spiked with CS_2 to the equivalent of 6000 ppm sulphur. After the feed flow had been started, the warm-up cycle was commenced at 28°C/h until the reactor reached 300°C (the first sulphiding temperature). The gas rate was set at 890 L/L of the gas oil with a minimum of 93% H_2 composition.
- Presulphiding was carried out at 3000 psig pressure and 1.0 LHSV and these conditions were maintained until the prescribed amount of sulphur had been passed over the catalyst. Each H_2S breakthrough was followed by a temperature increase of 30°C until 390°C was reached.
- The manufacturer's specifications were used to determine the percentage of sulphur added to the catalysts.
- The H_2S concentration in the effluent gas was monitored for 2 hours after the final breakthrough to ensure that sulfiding was complete.

3.4 Microreactor Tests

3.4.1 Apparatus

The continuous flow, in-house constructed reactor system shown in Figure 1 was used in the study. The feed reservoir was a 250 cc burette connected to Waters Model 510 metering pump. The stainless steel reactor itself was 18 cm long by 0.9 cm I.D.*, inserted into a bronze jacket equipped with a thermocouple. The reactor was placed in Varian Model 3700 oven, which was continually purged with nitrogen during reaction periods. The nominal bed size was approximately 11 cc. The bed was supported by a layer (1 mm) of glass wool. A back-pressure regulator was used to retain the required pressure in the system. The product stream passed through a two-stage receiver system, where liquid-gas separation took place. Off gases passed through a gas sampling orsat, a wet test meter and then to vent.

3.4.2 Operating Procedure

In obtaining experimental data on catalytic hydrocracking considerable attention was necessary to ensure constant reaction conditions, mass balancing and sample integrity. Therefore, stabilization of reactor pressures and temperatures as well as feed charge and product flow rates were monitored. In addition, a level of the catalyst activity was monitored by measuring density of the liquid effluent in four-hour increments.

For the microreactor runs involving fresh catalyst, the following procedure was developed:

*NOTE: The reactor dimensions and catalyst particle size were selected to comply with recommendations drawn from findings reported elsewhere (D. E. Mears, Chem. Eng. Sci. 26(1971) 1361, A. Iannibello et al., Ind. Eng. Chem. Process Des. Dev. 22 (1983) 594.

MICROREACTOR DIAGRAM

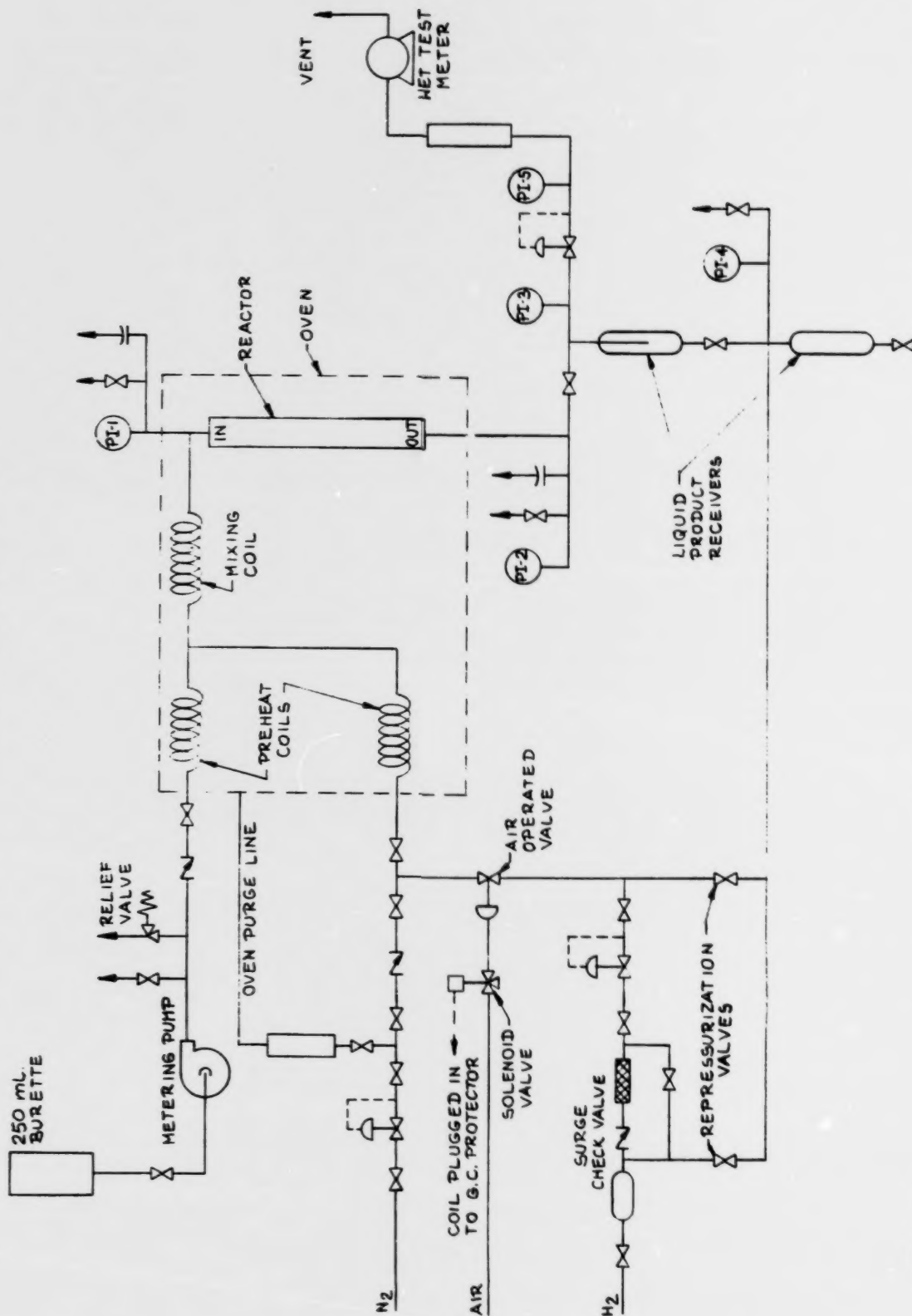


FIGURE 1

- PI- GAUGE
- Δ VALVE
- N CHECK VALVE

1. The reactor tube was loaded with the catalyst and sealed.
2. The catalyst was dehydrated at 190°C under nitrogen over 24 hours.
3. The reactor was then pressure tested at 20.7 MPa for 24 hours.
4. The liquid feed (5.4 cc/h) and hydrogen (5.4 L/h) flows were started with the reactor pressure maintained at 20.7 MPa. Hydrogen flow was controlled to produce a hydrogen to feed oil ratio of 1000 L/l L of gas oil.
5. The reactor was then heated at 3°C/min to 390°C.
6. At 390°C an initial catalyst activity decreased steadily until an equilibrium between the presulphided catalyst and sulfur content of the feed was reached. This was considered to be the steady-state catalytic activity and it usually required several days to develop. With the equilibrated catalyst feed charge required only several hours to achieve stable catalytic activity.
7. Samples of liquid product were drained at 4 h intervals, while temperatures, pressures and feed flow rate were recorded. The liquid product rate was determined by weighing drained liquid effluent samples.
8. Samples submitted for sulfur and nitrogen analyses were washed twice with equal amounts of 15% w/v cadmium sulphate acidified with 0.4N sulfuric acid followed by three separate water washes to remove residual cadmium sulfide and ammonium salts.

3.5 Pilot Reactor Tests

3.5.1 Description of the Pilot Plant Reactor

The P-16 reactor unit (Figure 2) consisted of a 5-foot reactor tube, feed pump, electric preheater and reactor heaters, liquid-gas separators, product cooler, pressure regulators and a wet test meter.

The reactor tube was 0.56 inch I.D., with 14 inches of ceramic beads on top followed by 43 inches (150 cc) of catalyst bed and another 3 inches of ceramic beads at the bottom. It had a 3/16-inch thermowell in the middle running from top to bottom. The thermowell contained 3 thermocouples, one located 4 inches from the top, one in the middle and one 4 inches from the bottom of the catalyst bed. The reactor temperature profile was controlled by the top heater (TIC-2) and the bottom heater (TIC-3).

The reactor unit was equipped with high-temperature and high-pressure alarms.

The oil was pumped to the top of the reactor (V-1) through a preheater and simultaneously the hydrogen was also fed concurrently with the oil from a pressure regulator (PC-1). The upstream hydrogen supply was 3500 psig and the pressure regulator controlled it to the desired operating pressure. The oil and hydrogen flowed down the catalyst bed in the reactor into a knock-out pot (V-6), to the cooler (HE-1) and into the liquid-gas separator (V-2) where the liquid level was maintained by DP-2 through a control valve (CV-2). From CV-2 the hydrotreated oil flowed into the product reservoir V-3, where it was drained regularly and weighed for material balance. The gas from the liquid-gas separator passed through a control valve (CV-1), into knock-out pot (V-5) and out to the vent through a rotameter and a wet test meter. The gas flow was controlled by a metering needle valve up-stream and the gas rate was read from the wet test meter. The gas was sampled through an Orsat before the wet test meter.

3.5.2 Procedure

Twelve-day production runs were carried out on the P-16 reactor using 2 catalysts:

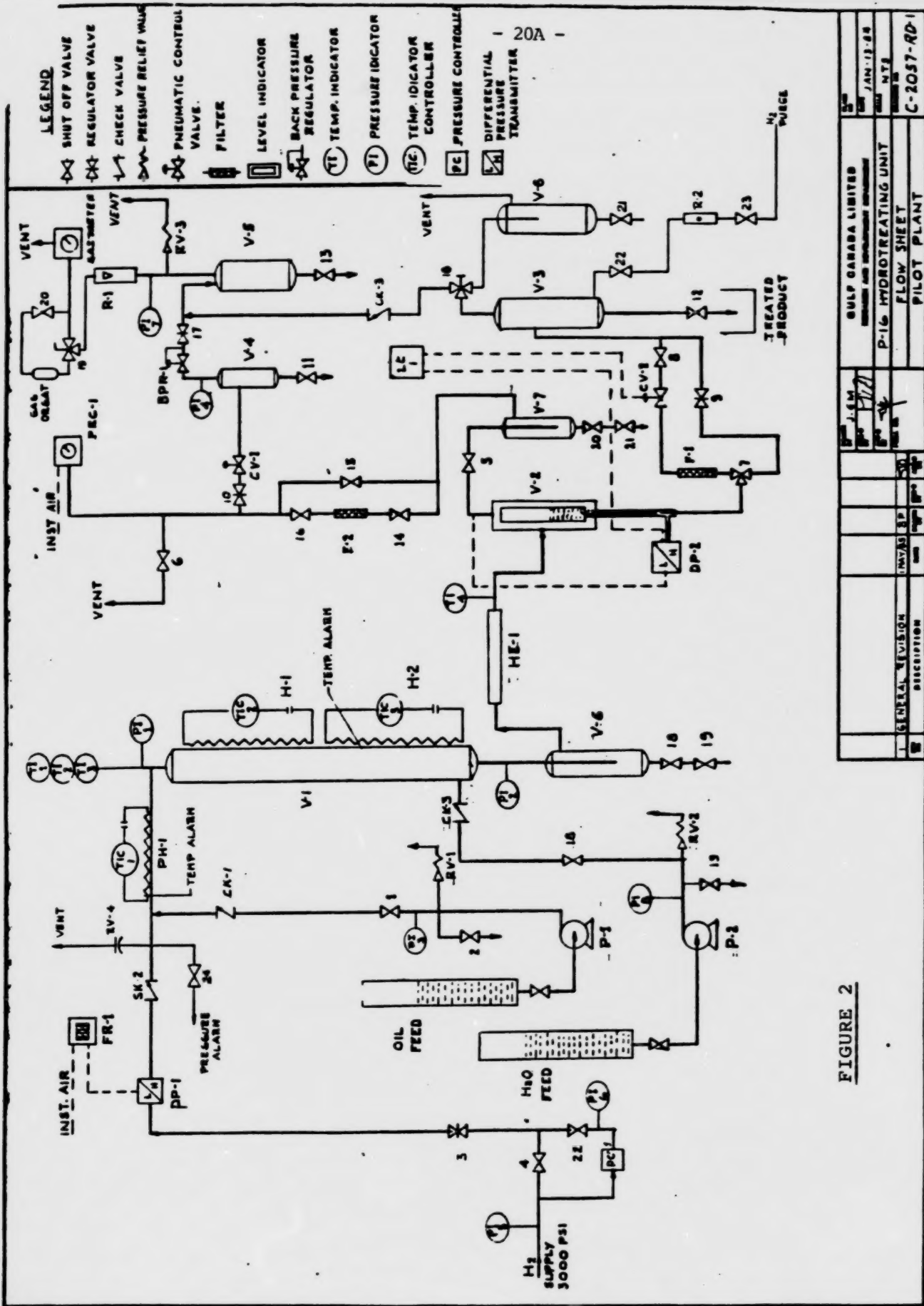


FIGURE 2

GULF CARBON LIMITED		P-16 HYDROTREATING UNIT		PILOT PLANT	
JAN. 12. 68		FLOW SHEET		C-2057-RD-1	
REV. 1		REV. 1		REV. 1	
GENERAL REVISION		DESCRIPTION		DESCRIPTION	

- . Ni/W zeolite
- . Harshaw Ni 4301E

Catalyst presulfiding was done over a 48-hour period using a hydrotreated base oil spiked with 0.6% carbon disulfide.

The hydrogenation was done at 3000 psig and 0.5 LHSV.

The hydrogen was supplied on a once-through basis, at the rate of 1300 litres H₂ per litre of feed.

Total liquid product samples were taken at 4 hour intervals and composited daily. Day 3, 6, 9 and 12 samples were analyzed for sulfur, total and basic nitrogen, GC distillation and UV aromatics. TBP distillations were done on the total liquid product as produced from the Ni 4301 runs.

In addition, other runs on the SGO and DSGO were done on the equilibrated Ni 4301E. Lower severity tests employed the fresher (150 cc) catalyst bed. The higher severity tests were performed employing 100 cc bed of the same but aged catalyst. The catalyst aging was accomplished when storing the catalyst in the SGO at ambient temperature over approximately 6 months.

3.6 Product Characterization

Determination of Density

Density of the total liquid product was measured accurately in four hour intervals using a Digital Precision Density Meter, Model DMA45 (Paar, Austria)

Determination of Nitrogen

The nitrogen content of liquid samples was determined measuring chemiluminescence of nitric oxide as described elsewhere (H.V. Drushel, Anal. Chem. 49(1977) 932). The Antek Nitrogen Detector (Antek Instruments, Inc., from Houston, Texas) was used.

Determination of Sulfur

A routine method based on ASTM D3120 was employed using Dohrmann, Environtech microcoulometer.

Simulated Distillation Analysis

The boiling point distribution of the liquid effluent samples was determined by gas chromatography based simulated distillation (GCD). The obtained boiling point distribution curves were expressed as a cumulative area (total area up to a given time) versus time relationship. Then, they were reported as cumulative volume percent distilled versus boiling point.

Determination of Aromatic Hydrocarbon Types

Solutions of approximately 0.1 g of liquid sample in 50 mL of cyclohexane were prepared. The concentrations of mono-, di- and polynuclear-aromatics were determined by means of ultraviolet spectroscopy measuring the absorbances at 198 nm, 228 nm and 260 nm, respectively.

Analysis of Gas Effluent

The molecules which make up a gas effluent sample were ionized and dissociated by electron bombardment in a mass spectrometer and a mass spectrum was recorded. The quantitative analysis for

hydrogen, oxygen, nitrogen, carbon monoxide, carbon dioxide, hydrogen sulfide, water and twenty-seven C_1 - C_8 hydrocarbons (or hydrocarbon types) was performed. Contributions of water and nine C_6 - C_8 hydrocarbons to the spectrum were removed to determine contents of eighteen hydrocarbons and noncondensable gases by solution of simultaneous equations.

4. RESULTS

4.1 Microreactor Runs

The following hydrogenation experiments were performed:

Exp. No.	FEED/REF. FEED/PROCEDURE	Length of Experiment Days (F/RF)
1	SGO/none/activity testing at 390°C	10/0
2	DSGO/SGO/activity testing at 390°C	8/2
3	DSCGO + SGO extract/SGO/hydrocracking at 390°C	8/2
4	DSGO + SCGO extract/SGO hydrocracking at 390°C	8/2
5	SGO/DSGO hydrocracking at 390°C	Total 30(3x8/2)
6	SCGO/DSCGO/hydrocracking at 390°C	6/2
7	Doped SGO; hydrocracking at 390°C, model feeds in order as per Table 2	6 days with carbazole feed followed by model feeds and ref. runs, 2.5/2.5.
8	RUNS IN ORDER AS LISTED BELOW:	
	- DSGO; hydrogenations at 360, 370, 380 and 385°C	2.5 at given temp.
	- SGO/DSGO/hydrogenation at 330°C	2.5/2.5
	- Resulfiding with DSGO containing 0.6% of dimethyl disulfide; hydrogenation (start at 240°C for 8 h, 20°C increase every 8 h up to 320°C)	
	- SGO/DSGO hydrocracking at 390°C	7/3
	- Catalytically Denitrogenated SGO/none/hydrocracking at 390°C.	3/0

Each experiment was carried out with fresh presulfided catalyst except Exp. 8 which employed catalyst used in Exp. 5.

Tables 5 and 6 compile inspections and yields of products from the experiments #1 and 2, respectively. Following the development of computer program for processing and storing raw data (see Appendix 1), all the other experiments were reported as separate 'Hydro-cracking Reports' (see attachments). Those reports show product yields on weight basis estimated using gas chromatographic distillation. The same density values were used to assess liquid volume yields of products generated in the experiments 2-8. Those values have been determined for cuts obtained from fractionated liquid effluent collected on the sixth day of the experiment #1.

All the product yields were calculated per 1 L of feed.

TABLE 5 Microreactor Exp. #1, Raw Syncrude Gas Oil - 10 Days Run

	<u>Feed</u>	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>	<u>Day 4</u>	<u>Day 5</u>	<u>Day 6</u>	<u>Day 7</u>	<u>Day 8</u>	<u>Day 9</u>	<u>Day 10</u>
<u>Yields:</u>											
Liq. Recovery, % w/w	-	-	-	-	-	99.1	99.5	-	-	-	-
Liq. Recovery, % v/v	-	-	-	-	-	108.0	108.4	-	-	-	-
Overhead Gas, % w/w	-	-	-	-	-	1.1	2.5	-	-	-	-
Total Prod. Recov. % w/w	-	-	-	-	-	100.2	101.7	-	-	-	-
Total Prod. Recov. % L/v	-	-	-	-	-	109.5	111.2	-	-	-	-
<u>PRODUCT INSPECTIONS</u>											
<u>Overhead Gas, % v/v</u>											
Hydrogen	-	-	-	-	-	99.26	98.83	-	-	-	-
Hydrogen Sulfide	-	-	-	-	-	0.10	0.12	-	-	-	-
Methane	-	-	-	-	-	0.25	0.23	-	-	-	-
Ethane	-	-	-	-	-	0.06	0.08	-	-	-	-
Propane	-	-	-	-	-	0.23	0.30	-	-	-	-
Isobutane	-	-	-	-	-	0.10	0.32	-	-	-	-
Isopentane	-	-	-	-	-	-	0.12	-	-	-	-
<u>Liquid Product</u>											
<u>GCD Distillation, °C</u>											
IBP	205	3	3	11	22	17	21	-	21	20	21
10	289	119	121	128	141	136	138	-	141	141	142
20	321	174	179	191	206	200	203	-	205	205	206
30	344	218	222	235	251	245	248	-	251	251	252
40	362	257	261	272	286	280	282	-	285	285	285
50	378	290	293	302	314	308	311	-	312	312	313
60	396	320	322	330	340	335	337	-	338	338	338
70	417	348	350	356	365	360	362	-	363	363	363
80	441	378	389	385	393	389	391	-	391	391	391
90	473	422	425	429	441	431	433	-	435	433	434
FBP	572	531	533	534	537	534	539	-	540	539	539
<u>UV Aromatics, % M/M</u>											
Monoaromatics	41.72	7.61	9.67	10.88	14.78	13.63	14.97	-	16.35	15.65	15.29
Diaromatics	8.60	-	-	-	0.12	0.30	0.33	-	0.17	0.13	0.14
P.N.A.	6.22	0.07	0.05	0.08	0.16	0.08	0.12	-	0.23	0.17	0.16
Total Nitrogen, ppm w/w	963	-	<1	3.6	9.4	<1	<1	-	3.1	1.2	1.1
Basic Nitrogen, ppm w/w	200	-	-	-	-	-	-	-	-	-	-
Total Sulfur, ppm w/w	1500	-	6	29	80	14	77	-	23	25	23
Water, ppm w/w	157	-	-	-	-	-	-	-	-	-	-
TAN, mg KOH/g sample	0.02	-	-	-	-	-	-	-	-	-	-
Density, kg/m ³ @ 15°C	0.9334	0.8405	0.8450	0.8515	0.8575	0.8555	0.8550	0.8595	0.8605	0.8600	0.8602
<u>Product Yields, % L/v</u>											
C ₂ -C ₅ Overhead Gas	-	-	-	-	-	1.6	3.9	-	-	-	-
IBP-195°C Naphtha	-	-	-	-	-	20.4	19.5	-	-	-	-
195-290°C LSRD	-	-	-	-	-	24.0	23.2	-	-	-	-
290-360°C HSRD	-	-	-	-	-	25.2	24.6	-	-	-	-
360°C+ Resid	-	-	-	-	-	28.8	28.8	-	-	-	-

TABLE 6 Microreactor Exp. #2, Denitrogenated Syncrude Gas Oil
(8 days run) and Raw Syncrude Gas Oil (2 days run)

	DSGO <u>Feed</u>	Day 6 <u>Product</u>	Day 8 <u>Product</u>	Day 10 Product <u>Reference</u>
<u>Yields:</u>				
Liq. Recovery, % w/w	-	99.1	98.6	99.7
Liq. Recovery, % v/v	-	114.3	113.8	109.1
Overhead Gas, % w/w	-	1.3	1.7	1.0
Total Prod. Recov. % w/w	-	100.3	100.3	100.7
Total Prod. Recov. % L/v	-	116.4	116.7	110.9
<u>PRODUCT INSPECTIONS</u>				
<u>Overhead Gas, % v/v</u>				
Hydrogen	-	99.25	99.03	99.37
Hydrogen Sulfide	-	0.05	0.07	0.06
Methane	-	0.18	0.31	0.22
Ethane	-	0.03	-	0.05
Propane	-	0.09	0.36	0.20
Isobutane	-	0.20	0.23	0.10
Isopentane	-	-	-	-
<u>Liquid Product</u>				
<u>GCD Distillation, °C</u>				
IBP	236	-19	-22	8
10	297	91	90	125
20	326	124	122	189
30	346	162	156	233
40	363	195	191	270
50	379	229	222	300
60	398	266	259	328
70	418	301	294	355
80	442	339	331	384
90	474	385	377	428
FBP	573	504	498	533
<u>UV Aromatics, % M/M</u>				
Monoaromatics	40.48	3.74	4.48	14.35
Diaromatics	7.50	-	-	-
P.N.A.	5.06	0.03	0.01	0.13
Total Nitrogen, ppm w/w	246	4.9	4.3	3.3
Basic Nitrogen, ppm w/w	<2	-	-	-
Total Sulfur, ppm w/w	1200	5	11	-
Water, ppm w/w	140	-	-	-
Density, kg/m ³ @ 15°C	0.9295	0.8100	0.8105	0.8525
<u>Product Yields, % L/v</u>				
C ₂ -C ₃ Overhead Gas	-	2.4	3.1	1.7
IBP-195°C Naphtha	-	41.6	42.7	23.0
195-290°C LSRD	-	25.8	26.0	24.7
290-360°C HSRD	-	16.4	16.3	24.0
360°C+ Resid	-	19.8	11.9	26.6

4.2 Pilot Reactor Runs

Table 7 shows run conditions and results obtained with the experimental zeolite catalyst. Information on the run #2, which employed Harshaw 4301E catalyst, is reported in Table 8. Run conditions and yields for low severity hydrogenations of SGO and DSGO are shown in Table 9, while those for higher severity hydrogenations on aged catalyst are summarized in Table 10.

- 26B -

TABLE 7 (continued)

RUN #1

Zeolite - 12 Day Run (continued)

(b) Feed & TLP Tests
P-16 Zeolite Study
Run No. 1 - April 9-26, 1985
0.5 LHSV, Experimental Zeolite Catalyst
3000 psig pressure

	<u>Feed</u>	<u>TLP</u>			
		<u>Day 3</u>	<u>Day 6</u>	<u>Day 9</u>	<u>Day 12</u>
Reactor Temp. °C					
Wt. avg.		350	350	350	370
Max.		360	359	358	381
Catalyst Life BBL/lb		0.11	0.23	0.33	0.43
Sp. Gravity	0.932	0.831	0.864	0.875	0.817
°API	20.2	38.7	32.1	30.2	41.7
Total N ppm	890	40	63	57	3
Basic N ppm	200	8	16	13	1
Total S wt.%	0.21	0.02	0.03	0.03	0.01
U.V. Aromatics					
Mono	30.5	7.8	16.4	19.7	4.3
Di	6.9	0.2	0.5	0.5	-
Tri +	<u>4.7</u>	<u>0.2</u>	<u>0.3</u>	<u>0.4</u>	<u>-</u>
Total	42.1	8.2	17.2	20.6	4.3
GCD, vol.% 360°	40	73.5	62.0	57.8	78.0
Approx. Conv. %	0	56	37	30	63
GCD 50% BP°C	376	249	325	339	224
wt.% H ₂ content (calc.)	11.4	13.5	13.0	12.8	13.6

- 26C -

TABLE 7 (continued)

RUN #1

Zeolite - 12 Day Run (continued)

(c) Weight Balance and Gas Analysis

<u>Weight Balance</u> <u>g per 8 h</u>	<u>3</u>	<u>6</u>	<u>Day</u> <u>9</u>	<u>12</u>
Gas Oil Feed	555	555	553	555
Hydrogen (calculated)	<u>10</u>	<u>7</u>	<u>6</u>	<u>12</u>
Total Feed	565	562	559	567
Products				
TLP	543	544	541	557
Gas (by difference)	22	18	18	30

Gas Analysis

<u>Mole %</u>	<u>3</u>	<u>Day</u> <u>12</u>
H ₂	98.0	98.4
H ₂ S	0.1	0.1
C ₁	0.2	-
C ₂	0.1	-
C ₃	0.4	0.4
C ₄	0.5	0.5
C ₅	0.1	0.1
inerts	0.6	0.5

- 26D -

TABLE 8

RUN #2

Harshaw 4301E - 12 Day Run

(a) Total Liquid Product Densities
Run No. 2 Harshaw Ni 4301 Catalyst

<u>Day</u>	<u>Date</u>	<u>°API</u>	<u>TLP</u> <u>Sp. Grav.</u>	<u>Avg.</u> <u>Temp.°C</u>
1	May 12-13/85	34.1	0.8542	358
2	May 14/85	27.4	0.8904	358
3	" 15	27.0	0.8926	358
4	" 16	26.1	0.8974	360
5	" 17	26.7	0.8941	367
6	" 22	28.2	0.8854	374
7	" 23	31.8	0.8662	383
8	" 24	34.3	0.8529	383
9	" 27	33.9	0.8554	383
10	" 28	36.0	0.8442	383
11	" 29	37.5	0.8367	383
12	" 30	38.0	0.8344	383

TABLE 8 (continued)

RUN #2

Harshaw 4301E - 12 Day Run (continued)

(b) Feed & TLP Tests

P-16 Harshaw Ni 4301 Catalyst

Run No. 2 - May 12-30, 1985

0.5 LHSV, 3000 psig pressure

	<u>Feed</u>	<u>TLP</u>			
		<u>Day 3</u>	<u>Day 6</u>	<u>Day 9</u>	<u>Day 12</u>
Reactor Temp. °C					
Wt. avg.		358	374	383	383
Max.		363	380	390	390
Catalyst Life BBL/lb		0.12	0.26	0.38	0.50
Sp. Gravity	0.932	0.8926	0.8854	0.8554	0.8344
°API	20.2	27.0	28.2	33.9	38.0
Total N ppm	890	7.0	3.4	3.2	2.0
Basic N ppm	200	1.9	0.5	0.5	0.2
Total S wt. %	0.21	0.02	0.01	0.01	0.01
U.V. Aromatics					
Mono	30.5	30.16	23.38	9.32	6.17
Di	6.9	1.23	0.91	-	-
Tri +	4.7	0.48	0.31	-	-
Total	42.1	31.88	24.50	9.32	6.17
GCD, vol. % 360°	40	52.5	55.0	68.7	78.0
Approx. Conv. %	-	21	25	48	63
GCD 50% BP°C	376	355	349	314	281
wt. % H ₂ content (calc.)	11.4	12.4	12.6	13.2	13.5
TBP Vol. % Yield					
(Day 8-12 composite)					
IBP-195°C	21.9				
195-290°C	27.3				
290-360°C	25.6				
360°C+	25.2				

- 26F -
TABLE 8 (continued)

RUN #2

Harshaw 4301E - 12 Day Run (continued)

(c) Weight Balance and Gas Analysis

<u>Weight Balance</u> <u>g per 8 h</u>	<u>3</u>	<u>6</u>	<u>Day</u> <u>9</u>	<u>12</u>
Gas Oil Feed	559	561	552	559
Hydrogen (calculated)	<u>4</u>	<u>4</u>	<u>9</u>	<u>11</u>
Total Feed	563	565	561	570
Products				
TLP	546	538	543	554
Gas (by difference)	17	27	18	16

Gas Analysis

<u>Mole %</u>	<u>6</u>	<u>Day</u> <u>9</u>	<u>12</u>
H ₂	99.65	99.31	99.01
H ₂ S	0.07	0.08	0.08
C ₁	0.05	0.08	0.11
C ₂	-	0.01	0.01
C ₃	0.09	0.22	0.30
C ₄	0.09	0.15	0.27
C ₅	0.03	0.02	0.04
inerts	0.02	0.13	0.18

TABLE 9

DAILY LIQUID PRODUCT DENSITIES

Feed	<u>RUN No. 4</u>			<u>RUN No. 3</u>		
	Syncrude G.O. D84-102-3			Denitrogenated Syncrude G.O.		
<u>DAY</u>	<u>°API</u>	<u>Sp. G.</u>	<u>Ave. Temp.°C</u>	<u>°API</u>	<u>Sp. G.</u>	<u>Ave. Temp.°C</u>
1	28.0	0.8869	373	34.3	0.8528	373
2	27.6	0.8891	373	35.3	0.8477	373
3	27.6	0.8891	373	36.0	0.8445	373
4	27.0	0.8891	373	36.6	0.8424	373
5	26.9	0.8929	373	37.8	0.8352	374
6	26.8	0.8933	373			
7	26.5	0.8949	373			
8	26.6	0.8944	373			

TABLE 9 (continued)

SUMMARY OF THE RUNS
ON CATALYST Ni-4301-E

	<u>RUN No. 3</u> (5-Day Run)	<u>RUN No. 4</u> (8-Day Run)
Feed	Denitrogenated Syncrude G.O.	Syncrude G.O. D84-102-3
LHSV	0.50	0.49
Gas Rate (STD. CU.FT./BBL)	8,554	13,576
Ave. Temp., °C	373	373
Max. Temp., °C	380	378
Operating Pres., psig	3000	3000
Feed Density		
API	20.7	20.2
Dens. @ 15°C	0.9295	0.9320
TLP Density		
API	36.1	27.2
Dens. @ 15°C	0.8441	0.8909
Mass Balance, Wt. %		
TLP Yield	98.5	98.8
Gas Yield (by Diff.)	1.5	1.2
Cat. Life		
(BBLS/lb approx.)	0.61	0.85
TBP Vol.% Yield	(Vol.%)	(Vol.%)
IBP-195°C	21.2	5.8
195-290°C	19.1	16.8
290-360°C	28.5	32.1
360°C+	31.3	45.3

TABLE 10

DAILY SUMMARY

<u>Feed</u>	<u>RUN No.5</u>		<u>Run No. 6</u>		
	<u>Denitrogenated</u>		<u>Syncrude Gas Oil</u>		
			<u>D84-102</u>		
	°C				
	<u>Avg.</u>	<u>Max.</u>	<u>TLP</u>	<u>Avg.</u>	<u>Max.</u>
	<u>Bed.</u>	<u>Bed.</u>	<u>S.G.</u>	<u>Bed.</u>	<u>Bed.</u>
			<u>@ 15</u>		<u>TLP</u>
					<u>S.G.</u>
					<u>@ 15</u>
<u>Day</u>	<u>Date</u>				
1	Jan.22/86	383.3	392	.8716	
2	23	383.5	393	.8623	
3	24	383.5	393	.8551	
4	25	383	392	.8532	
5	29	383	392	.8455	
6	30	382.5	391	.8430	
7	31	382.7	391	.8395	
1	Feb.3/86			383.3	390 .8723
2	4			383.0	390 .8716
3	5			383.0	389 .8709
4	6			383.0	389 .8694

TABLE 10 (continued)

SUMMARY OF THE RUNS ON P-16
CATALYST Ni-4301-E

	<u>RUN NO. 5</u> <u>(7-Day Run)</u>	<u>RUN NO. 6</u> <u>(4-Day Run)</u>
Feed	Denitrogenated Syncrude G.O.	Syncrude G.O. D84-102-3
LHSV	0.50	0.50
Gas Rate (STD. CU.FT./BBL)	5,000	5,000
Ave. Temp., °C	383	383
Max. Temp., °C	392	390
Operating Pres., psig	3000	3000
Feed Density		
API	21.0	20.4
Dens. @ 15°C	.9273	.9316
TLP Density		
API	34.4	30.9
Dens. @ 15°C	.8532	.8712
Mass Balance, Wt. %		
TLP Yield	98.7	98.8
Gas Yield (by Diff.)	1.3	1.2
Cat. Life (BBLs/lb approx.)	1.10	1.24
TBP Vol. % Yield		
IBP-195°C	17.8	9.4
195-290°C	27.5	16.9
290-360°C	26.1	39.5
360°C+	28.1	34.0

5. DISCUSSION

5.1 Composition of Feeds

Raw and denitrogenated feeds were analyzed prior to hydrogenation to examine compositional differences (Table 1). Only minor differences in hydrocarbon distribution were observed by means of UV spectroscopy and mass spectrometry. The densities of the denitrogenated feedstocks were slightly lower. The sulfur contents were also slightly lower in the denitrogenated feedstocks. Their initial boiling points were higher, probably due to losses of the lighter material when distilling off water. The major differences were observed in the total- and basic-nitrogen contents. The total nitrogen content of SGO has been reduced 75%, while its basic nitrogen components removed almost completely.

The DSCGO was found to contain 66% less nitrogen species than raw SGO.

5.2 Catalyst Activity

Our initial efforts to design tests for studying hydrocracking of model feeds have been focused on determining/characterizing a steady-state of the catalyst activity. In the experiment #1 employing SGO, a level of the catalyst activity was monitored by measuring density of the reactor effluent every four hours and determining contents of nitrogen, sulfur, aromatic hydrocarbons and naphtha fraction daily (see Figure 3). After significant decline in the activity during the initial stage of the run, less dramatic changes were observed. The results obtained indicated that approximately steady-state sulfur, nitrogen and hydrocarbon conversions had been achieved after 6 days-on-stream, i.e. the catalyst de-edging required minimum 6 days contact with SGO at 390°C.

There was no further decline in the catalyst activity observed for run extended to 30 days (see Figure 4). The steady-state conversions were achieved both for SGO and DSGO during 30 day period. Since the characteristics of the day 10, 20 and 30 products, derived from DSGO, were repeatable, DSGO was chosen to be a reference feed for the tests with model feeds. Consequently, the characteristics of the liquid effluent from the experiment #2 were not used as reference data. It was concluded that they were different from those of day 10, 20 and 30, due to unfinished process of catalyst de-edging

Fresh and used catalyst samples were analyzed for the total nitrogen content (Table 11). A dependence between nitrogen deposited on the catalyst and exposure to the feed nitrogen was apparent. The longer the exposure, the higher the nitrogen content was observed.

HYDROCRACKING OF RAW SYNCRUDE GAS OIL

- 28A -

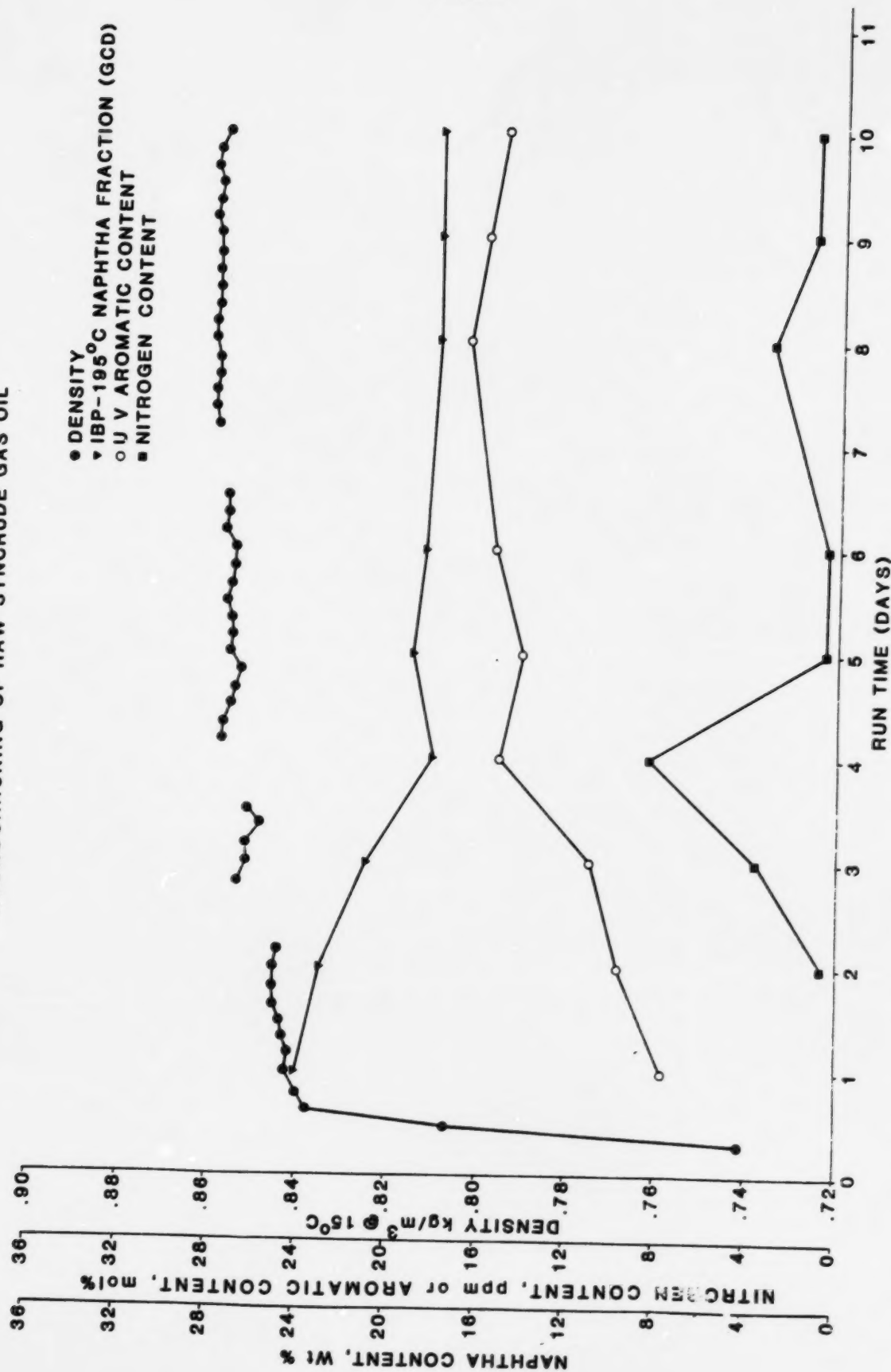


FIGURE 3

HYDROCRACKING OF SYNCRUDE GAS OIL

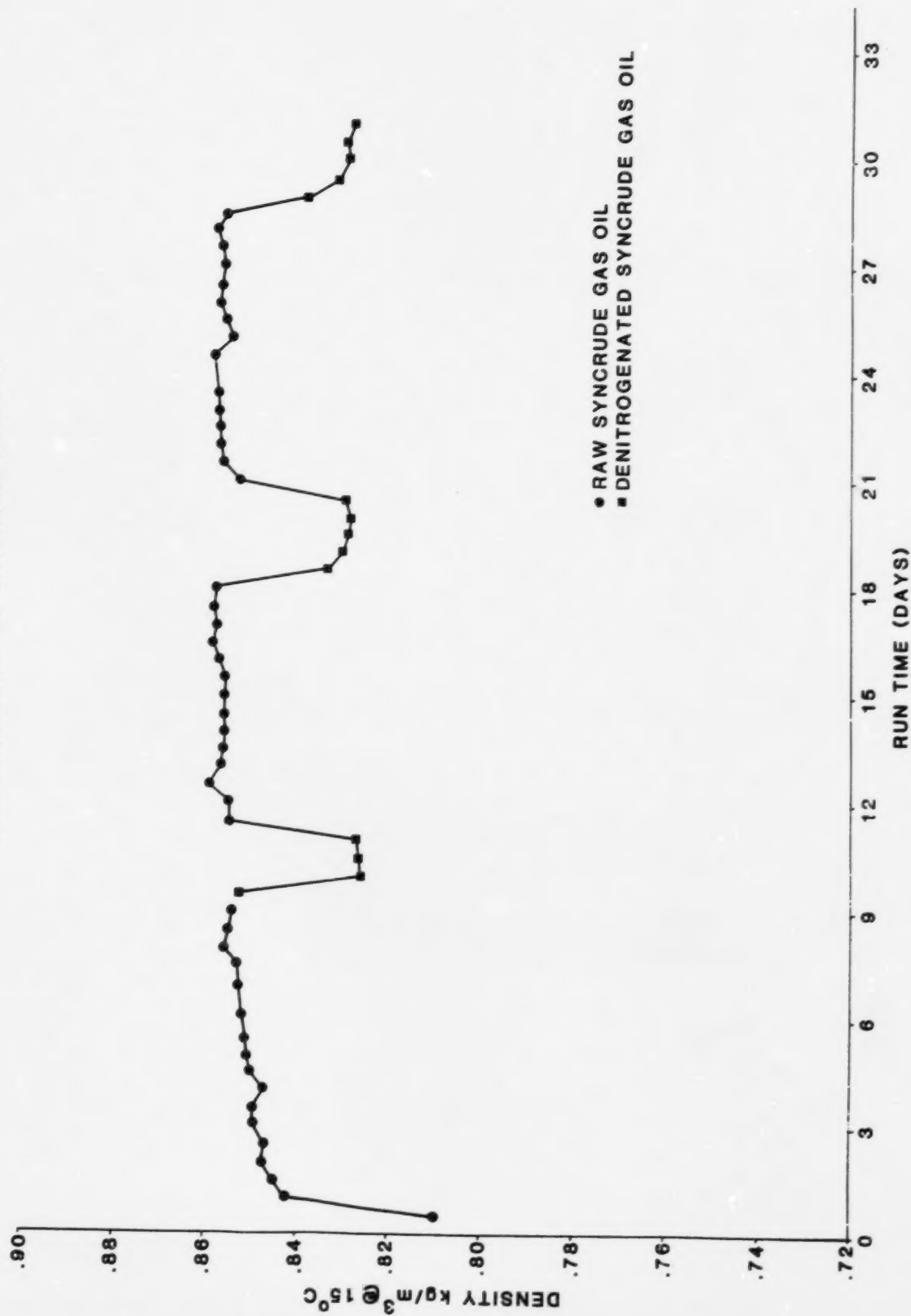


FIGURE 4

TABLE 11

ANALYSES OF FRESH AND USED CATALYST SAMPLES
FOR TOTAL NITROGEN CONTENT, ppm w/w

Experiment	Feed x Days	Catalyst Sample	Exposure to Nitrogen in the Feed (Days x Feed Nitrogen Content, ppm)	Total Nitrogen Content of Catalyst Sampled
-	-	fresh	none	100
2	DSGO x 8, SGO x 2	used	8 x 246 and 2 x 963, respectively	5222
1	SGO x 10	used	10 x 963	6100
4	(DSGO + SCGO extract) x 8, SGO x 2	used	8 x 1145 and 2 x 963, respectively	7325
3	(DSCGO + SGO extract) x 8, SGO x 2	used	8 x 1934 and 2 x 963, respectively	7710
6	SCGO x 8, DSCGO x 2	used	8 x 1934 and 2 x 664, respectively	9800

- 28C -

5.3 Hydrogenations of Raw and Denitrogenated Feedstocks

Tables 12-14 summarize yields and conversions observed by hydrogenating raw and denitrogenated feeds.

5.3.1 Experiments #5 and 8

Both experiments were carried out using the same catalyst bed. The 30 day run at 390°C had revealed that density of the TLP decreases when switching from raw to denitrogenated SGO. Consistent product characteristics were observed during the whole run. Significant enhancement of the naphtha yield and a higher yield of the light distillate were achieved for DSGO in comparison to SGO (see attached 'Hydrocracking Reports'). Lower product yields were obtained hydrogenating DSGO at 360, 370 and 380°C. The yields observed at 385°C for DSGO were similar to those obtained for raw SGO at 390°C. In addition, the conversion defined as:

$$\text{CONVERSION} = \frac{C_F - C_{\text{TLP}}}{C_F}$$

where: C_F and C_{TLP} are gas oil (360°C+) contents in feed & total liquid product, respectively. was the same.

The hydrogenations performed at 330°C on SGO and DSGO did ^{NOT} indicate any significant differences in conversion and hydrocarbon distribution. This observation led to the conclusion that only the hydrocracking mode is affected by denitrogenation, while the hydro-treating reactions are not influenced by nitrogen species.

Following the completion of the hydrogenations at 390, 360, 370, 380, 385 and 330°C, the catalyst was resulfided. There was no change in catalyst activity observed when hydrogenating SGO no DSGO. Thus, it was apparent that the steady-state of the catalyst activity was maintained during the course of the experiments #5 and 8.

The experiment #8 was completed by running SGO catalytically denitrogenated prior to hydrogenation at 390°C. Naphtha yield was found to be similar to that of the chemically denitrogenated feed, while light distillate yield increased significantly for the catalytically denitrogenated SGO. Consequently, it became apparent tha

TABLE 12
INDIVIDUAL PRODUCT YIELDS
DETERMINED BY SIMULATED DISTILLATION
LIQUID vol. %

	EXP. #5		EXP. #8		EXP. #6	
	SGO	DSGO	Cat. DeN ₂	DSGO	SCGO	DSCGO
	DAY 28	DAY 30	DAY 3	DAY 3	DAY 6	DAY 10
	390°C	390°C	390°C	385°C	390°C	390°C
IBP-195°C	20.4	32.4	32.4	20.8	15.6	22.0
195-290°C	26.7	29.3	34.2	24.4	28.9	29.3
290-360°C	29.4	25.3	29.8	29.3	37.6	30.7
360°C+	31.1	24.0	24.5	33.4	31.0	22.4

TABLE 13

FRACTIONATIONS OF TOTAL LIQUID
PRODUCT, Liq. vol.8

	EXP. #5 (390°C)		EXP. #8 (385°C)		Pilot Reactor Runs (Fresh Catalyst)		
	SGO DAY 23	DSGO DAY 20	DSGO DAY 3		SGO 383°C	SGO 373°C	DSGO 373°C
IBP-195°C	12.1	23.2	12.5		21.9	5.8	21.2
195-290°C	24.0	27.3	20.0		27.3	16.8	19.1
290-360°C	32.1	27.9	30.5		25.6	32.1	28.5
360°C+	31.8	20.4	30.0		25.2	45.3	31.3

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	Pilot Reactor Runs (Aged Catalyst)	
	SGO 383°C	DSGO 383°C
IBP-195°C	9.4	17.8
195-290°C	16.9	27.5
290-360°C	39.5	26.1
360°C+	34.0	28.1

TABLE 14

MICRO REACTOR RUNS
HYDROCARBON DISTRIBUTION IN LIQUID EFFLUENTS*
MASS SPECTROMETRIC ANALYSES

Feed Type	T °C	IBP-195°C				195-290°C				290-360°C				360°C+				Conv. %
		ISO-P	N-P	C-P	A	N-P	C-P	A	N-P	C-P	A	N-P	C-P	A				
SGO	390	16.0	11.3	66.3	6.3	11.8	77.2	10.2	8.7	77.5	12.5	13.4	79.3	6.1	49**			
DSGO	390	20.7	12.0	64.7	2.5	14.4	81.9	3.2	14.4	79.0	5.5	20.8	74.9	3.3	66***			
DSGO	385	13.5	8.5	71.3	6.7	12.8	76.3	10.3	9.9	77.6	11.6	14.5	77.8	6.7	49			
SGO	330					10.6	51.7	37.0	5.5	44.2	50.3	7.4	43.7	47.3	6			
DSGO	330					8.4	53.1	37.6	4.0	47.7	48.3	7.1	42.1	49.4	8			

* Vol.%, except 360°C+ fraction which is in mass %

** Experiment #5, Day 23

*** Experiment #5, Day 20

that decrease in nitrogen content by both methods increases conversion to light liquid products.

5.3.2 Experiments #3, 4 and 6

The objective of these experiments was to examine an effect of nitrogen components of different origin on the hydrogenation at 390°C. The extracts from SGO and SCGO were reblended with the opposite raffinates to form two reconstituted feedstocks for comparing with corresponding raw materials. In our previous work [Ref.1] we have characterized the SCGO extract nitrogen components as predominantly basic, while nitrogen species extracted from SGO qualified as predominantly non-basic. Consequently, the reconstitutions yielded the pre-extraction nitrogen levels and altered predominance by specific type of nitrogen components.

Hydrocracking runs employing the reconstituted SCGO (Exp. #3) and reconstituted SGO (Exp. #4) resulted in product yields similar to those of corresponding raw gas oils. Thus, both experiments indicated that the hydrogenations of SGO and SCGO had been affected by the total nitrogen content of these feeds rather than type of nitrogen components.

The hydrogenations of raw SCGO and DSCGO (Exp. #6) have confirmed that nitrogen content influences the overall conversion. However, difference in naphtha yield was found to be smaller than that for SGO and DSGO in Experiment #5.

5.3.3 Pilot Reactor Runs

The two production runs were carried out to obtain sufficient amounts of naphthas and distillates for product evaluation. The runs were to confirm results obtained with the microreactor. In addition, one run employing zeolite catalyst was also performed.

In runs #1 and #2 the catalysts exhibited a high initial cracking activity. Harshaw Ni 4301E catalyst required 6-7 days 'de-edging' prior to production run. With the experimental catalyst the cracking and aromatic conversion declined on a daily basis throughout the run. It appeared that the zeolite catalyst activity loss amounted to about 15°C over the 12 day period. This was somewhat excessive. Therefore, the product evaluation was done only on those obtained using the Harshaw catalyst.

5.4 Hydrogenations of Model Feeds

The effect of nitrogen components on the conversion of SGO into liquid products was studied with regard to nitrogen functional group. Various model nitrogen compounds were added to DSGO prior to hydrogenation. The compounds represented specific types of nitrogen components such as basic type (2,3,5,7,8), non-basic-pyrrolic type (9,10), primary amines (1) and secondary amines (4). The intent was to hydrogenate feeds containing nitrogen at approximately pre-extraction concentrations or lower.

Three approximately linear relationships between the total nitrogen content and changes in characteristics of the total liquid product were observed (Fig. 5-7). The following characteristics appear to be influenced by nitrogen constituents:

$$\begin{array}{ll}
 \text{TLP density change} & - \Delta D_{\text{TLP}} = \frac{\text{Doped SGO}}{D_{\text{TLP}}} - \frac{\text{DSGO}}{D_{\text{TLP}}} \\
 \\
 \text{TLP mid-boiling point change} & - \Delta \text{MBP}_{\text{TLP}} = \frac{\text{MBP}_{\text{Doped SGO}}}{\text{MBP}_{\text{TLP}}} - \frac{\text{MBP}_{\text{DSGO}}}{\text{MBP}_{\text{TLP}}} \\
 \\
 \text{Naphtha content change} & - \Delta \text{NC}_{\text{TLP}} = \frac{\text{NC}_{\text{Doped SGO}}}{\text{NC}_{\text{TLP}}} - \frac{\text{NC}_{\text{DSGO}}}{\text{NC}_{\text{TLP}}}
 \end{array}$$

The hydrogenation of the acridine doped feed yielded TLP of low naphtha content and relatively high mid-boiling point. The TLP characteristics of all the other feeds were found to fall closely on both sides of the line connecting SGO and DSGO. Therefore, we have concluded that the conversion to light products is primarily dependant on the total nitrogen content for the studied compounds. Nitrogen functional groups appear to influence an extent of changes in the above characteristics to a small degree.

TLP DENSITY CHANGE vs. FEED NITROGEN CONTENT

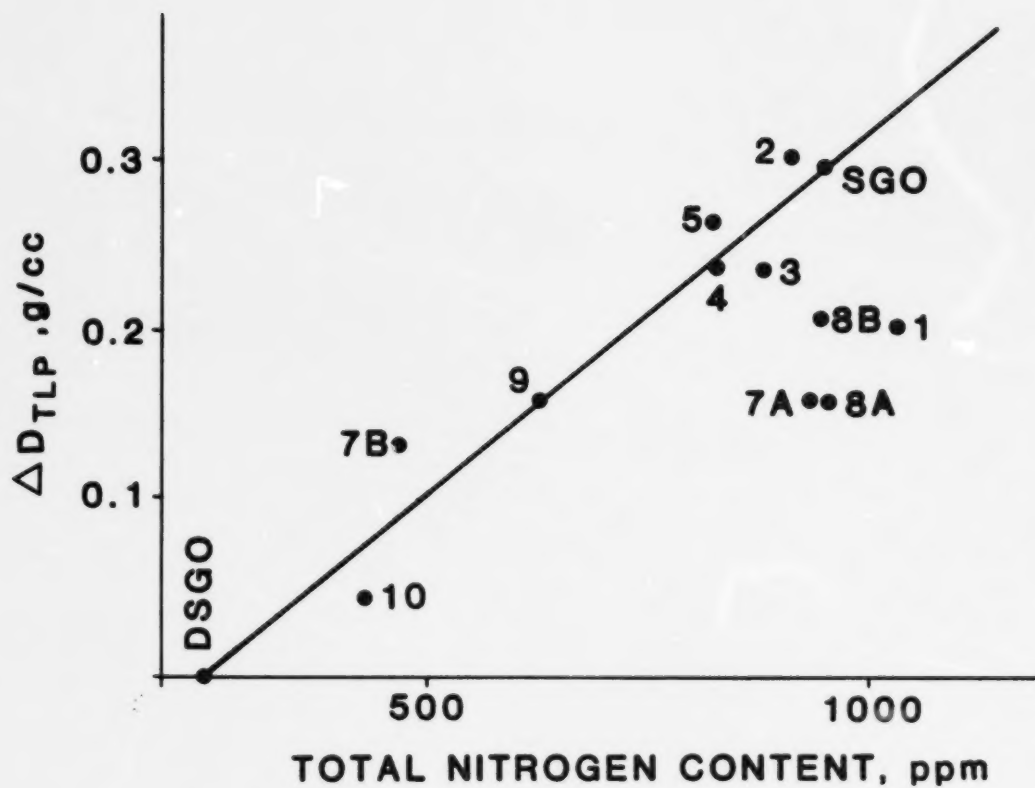


FIGURE 5

- 31B -

TLP MID-BOILING POINT CHANGE vs. FEED NITROGEN CONTENT

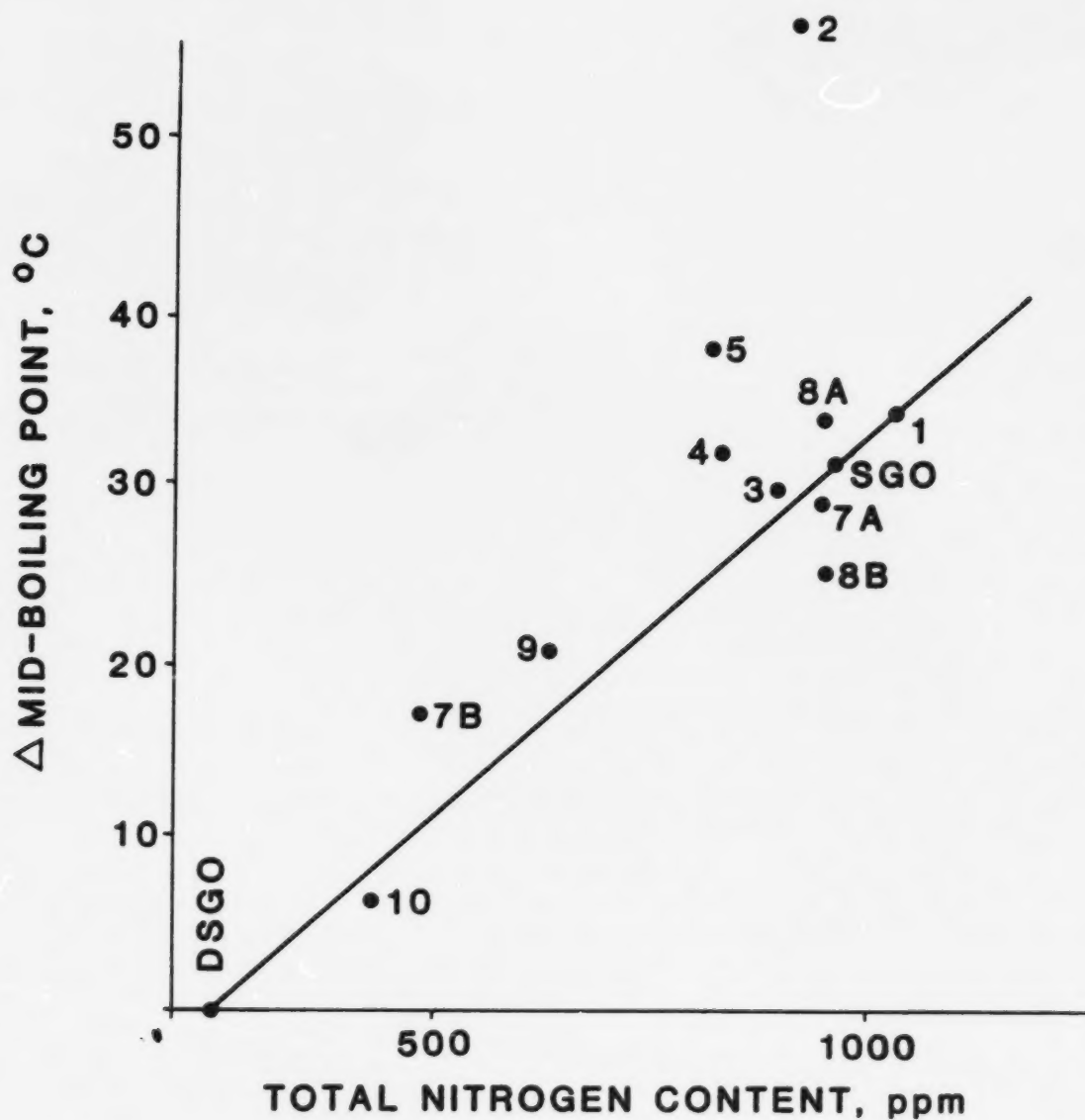
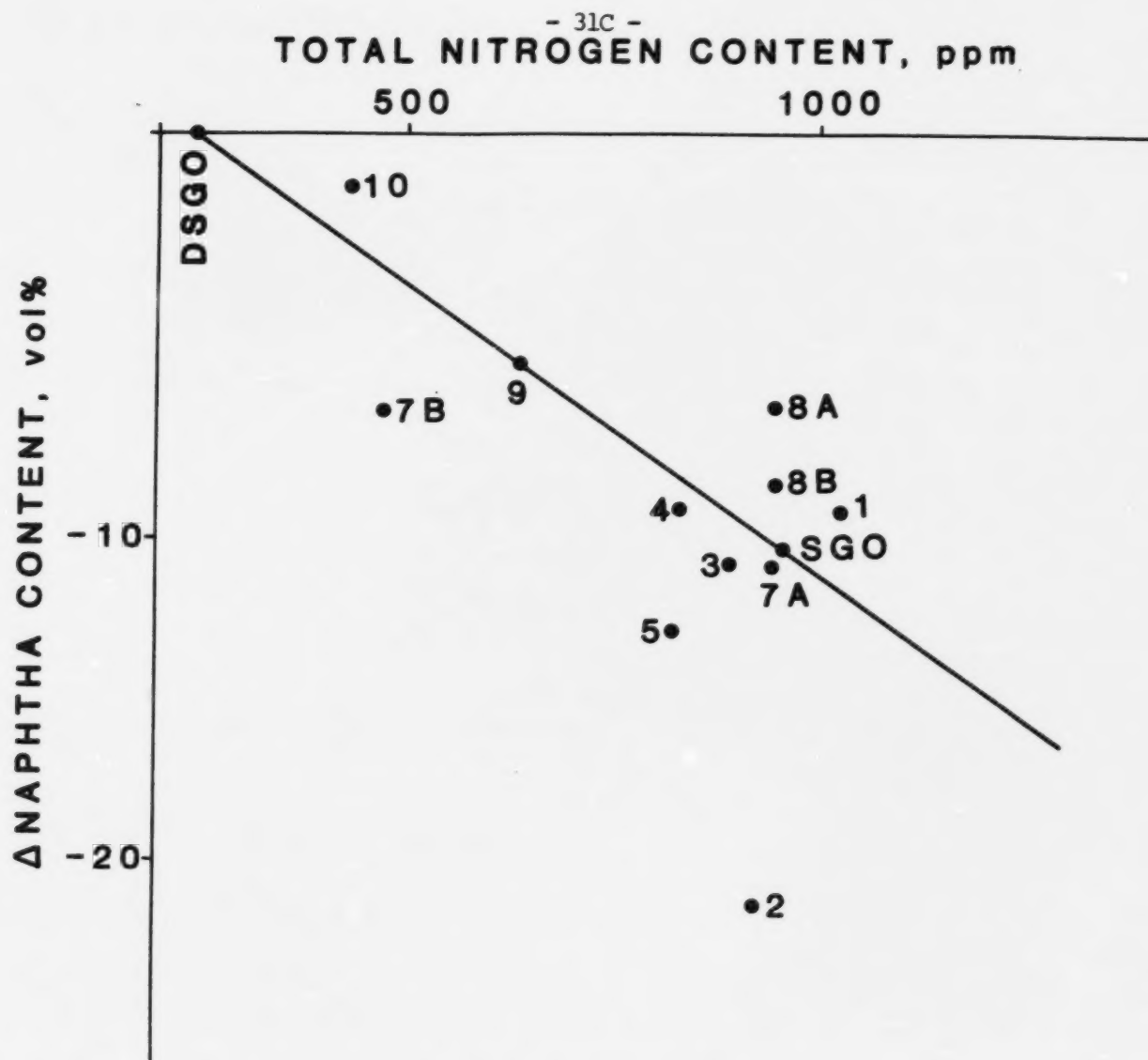


FIGURE 6



TLP NAPHTHA CONTENT CHANGE
vs. FEED NITROGEN CONTENT

FIGURE 7

5.5 Product Evaluation

5.5.1 Yield Structures

Individual product yields were determined for each microreactor run by means of simulated distillation (gas chromatographic distillation). Table 12 shows yield structures of selected microreactor effluents. The relationship between feedstock nitrogen content and enhancement of naphtha and light distillate yields is seen there for feeds denitrogenated either chemically or catalytically.

The fractionations reported in Table 13 have also confirmed observed earlier tendencies towards enhancing yields of naphtha and light distillate. While the fractionation yields differed from those determined by the simulated distillation, the differential yields were similar for both cases. The lower values of the fractionation yields were likely due to light end losses during distilling.

Amounts of the total liquid product collected during the course of microreactor runs did not permit individual product inspections. Therefore, the pilot reactor production runs were carried out to generate sufficient amounts of the TLP and, additionally, to obtain information on the effect of the hydrogenation severity and catalyst activity on product yields. These runs have revealed that the low severity hydrogenation of DSGO increases significantly naphtha yield, while higher severity treatment of DSGO on aged catalyst enhances markedly both naphtha and light distillate yields.

The yields compiled in Table 13 allow comparison of the effect of the denitrogenation with that of temperature, i.e. whether increase in catalyst activity with increasing temperature is equivalent to that due to the denitrogenation. Two pairs of TLP's were compared; namely, SGO hydrogenated at 390°C with DSGO hydrogenated at 385°C, and SGO processed at 383°C with DSGO processed at 373°C. Approximately the same naphtha yields were observed for each pair. The light distillate yields were higher for raw SGO hydrocracked at higher temperatures in comparison to the denitrogenated feedstock processed at temperature which had yielded the same conversion to naphtha.

5.5.2 Product Composition

Table 14 shows contents of hydrocarbon types in the fractionated microreactor effluents. The hydrogenations at 390°C yielded significantly lower aromatic contents in all the fractions derived from the denitrogenated feedstock. Simultaneously, higher contents of isoparaffins were observed for the naphtha. The other fractions of the same origin contained more normal- and cycloparaffins. The hydrogenation of DSGO at 385°C led to fractions of similar aromatic contents to those of the fractions of the raw SGO hydrogenated at 390°C. There were no major changes in hydrocarbon composition observed for hydrotreatments at 330°C. The mass spectrometric and elemental composition examinations have also revealed low concentrations of sulfur and nitrogen compounds in the fractionated effluents. The highest sulfur contents, mainly as aromatic sulfur compounds, occurred in heavy distillates. The nitrogen components were found mainly in the gas oil fraction of the effluent.

Fractionated effluents from the production runs were analyzed for hydrocarbon types by means of mass spectrometry (Table 15). The distributions of the hydrocarbon types followed approximately those observed for the microreactor effluents. The reported contents have also revealed that decreasing temperature and declining catalyst activity increase the aromatic content of all the analyzed fractions.

5.5.3 Product Inspections

Naphthas (Hydrogenation at 373°C)

The naphthas appear to be good reforming feedstocks because of large amounts (65-70%) of naphthenes (cycloparaffins). However, because these naphthas are very heavy, the reformate produced would be heavier than that from a straight-run conventional heavy naphtha.

Both naphthas were evaluated for octane blending values by determining octane values for blends consisting of component of known octane and naphtha in a ratio of 9:1. Assuming a linearity of changes in octane number values for these naphthas, the RON and MON values were calculated (Table 16). The difference in RON

TABLE 15

PILOT REACTOR RUNS
HYDROCARBON DISTRIBUTION IN LIQUID EFFLUENTS
MASS SPECTROMETRIC ANALYSES

Feed Type	T °C	IBP-195°C				195-290°C				290-360°C				360°C+			
		ISO-P	N-P	C-P	A	N-P	C-P	A	N-P	C-P	A	N-P	C-P	A	N-P	C-P	A
Fresh Catalyst	SGO	16.4	11.2	67.0	5.5	11.8	78.2	8.5	11.2	76.1	12.7	16.2	79.0	4.3			
	SGO	9.1	8.4	67.5	15.0	9.5	63.6	24.3	6.1	63.4	20.8	7.5	69.5	13.0			
	DSGO	17.9	11.9	65.6	4.6	11.2	82.0	5.1	11.1	78.8	10.1	14.6	79.5	4.3			
Aged Catalyst	SGO	14.1	12.0	65.9	8.0	9.3	76.0	13.7	7.1	73.5	17.8	10.5	75.9	12.3			
	DSGO	20.7	11.7	64.7	2.9	11.0	84.0	4.4	12.4	77.5	8.5	16.2	80.5	2.7			

TABLE 16

HYDROGENATIONS AT 373°C
INSPECTIONS OF PRODUCTS
DERIVED FROM SGO AND DSGO

	LSRD*		HSRD**	
	SGO	DSGO	SGO	DSGO
CETANE NUMBER	37.4	41.4	42.8	51.1
H CONTENT, wt. %	13.0	13.7	-	-
POUR POINT	<-62	<-62	-30	-33
CLOUD POINT	-49	<-62	-30	-32
FREEZE POINT	N/A	-64	-22	-24

OCTANE BLENDING VALUES	NAPHTHA	
	SGO	DSGO
RON	67.8	66.8
MON	64.2	71.2
H CONTENT, wt. %	13.54	14.39

* Light Straight Run Distillate
** Heavy Straight Run Distillate

value was within the experimental error. The MON values, however, seemed to indicate a better quality for naphtha derived from the denitrogenated feedstock, which was consistent with higher content of octane-increasing isoparaffins in the DSGO naphtha.

Middle Distillates

Light and heavy distillates were inspected to evaluate an effect of the denitrogenation on their characteristics and quality related parameters (Tables 16 and 17). Both cetane number and cetane index values increased as a result of the denitrogenation. The quality of the distillates also benefited from the trend towards decreasing pour-, cloud- and freeze- points due to the denitrogenation.

Solvents

The total liquid products were not distilled to obtain solvents. Nevertheless, low aromatic- and high cycloparaffinic- contents of the examined fractions of the DSGO effluent origin indicate a potential for producing high quality solvents.

TABLE 17
CETANE INDEX INSPECTIONS OF
MIDDLE DISTILLATE FRACTIONS
(ASTM D976)

FEED TYPE	T °C	FRACTION	CETANE INDEX
SGO	383	LSRD	40.2
		HSRD	48.2
SGO	373	LSRD	36.3
		HSRD	42.7
DSGO	373	LSRD	38.4
		HSRD	47.6
SGO	383	LSRD	35.2
		HSRD	42.8
DSGO	383	LSRD	39.6
		HSRD	48.2

FRESH
CATALYST

AGED
CATALYST

6. CONCLUSIONS

- At hydrocracking temperature range nitrogen components (presumably converted to ammonia) appear to block reversibly active surface sites;
- Nitrogen compounds inhibit cracking and aromatic ring saturation reactions;
- Gas oil conversion to light products is affected by the total nitrogen content of the hydrotreated feed. Nitrogen functional groups appear to change characteristics of the total liquid product to a small degree.
- Denitrogenation enhances naphtha and middle distillate yields. The yield enhancement is a function of hydrocracking severity;
- Hydrocracking of denitrogenated SGO yields light and heavy distillates of higher cetane number than those derived from raw SGO;
- Octane blending values appear to be higher for naphtha of DSGO origin.

7. FUTURE WORK/RECOMMENDATIONS

- (1) Two-stage catalytic hydroprocessing should be evaluated. A mild catalytic hydrogenation yielding hydrodenitrogenated feedstock is expected to substitute for denitrogenation by means of solvent extraction prior to hydrocracking.
- (2) Quality of products derived from blends of raw and denitrogenated feeds should be assessed.
- (3) Other types of hydrocracking catalysts should be screened for relationship between catalyst activity and nitrogen content.

8. ACKNOWLEDGEMENT

The author wishes to thank Mr. R.K. Lennox for his excellent technical assistance.

APPENDIX 1

HYCREP 3

```

10 REM HYDROCRACKING REPORT PROGRAM
15 REM TASK 366-84-65: THE IMPACT OF NITROGEN COMPOUNDS ON THE PROCESSING OF
20 REM SYNTHETIC GAS OIL
25 REM PROGRAMMED BY J G SPIRO, APRIL, 1985
30 DIM DEN(11), A(11), P(11), SG(3,11), GCD(3,11), NS(3,3), FBGD(11), RFG
  (11), PRD(4,4)
40 DIM X(11), Y(11), D(11), E(11), C(4,11), A(11,3), B(11), Z(11)
50 REM DENSITIES OF STABILIZER GAS COMPONENTS AT 1 ATM AND 273.16K, g/L
60 REM H2, C1, C2, C3, IC4, NC4, IC5, NCS, C6+, H2S, NH3
70 FOR BB=1 TO 11
80 READ DEN(BB)
90 NEXT BB
100 DATA .0899, .7157, 1.3415, 1.9659, 2.593
110 DATA 2.593, 3.219, 3.845, 1.52, .7597
120 REM 1BP 195C, 195-290C, 290-360C AND 360C+ DENSITIES AT 15C, g/cc
125 DATA 0.85,0.90,0.9753,0.0.85,0.90,0.9679,0.7815,0.8485,0.8795,0.8875,0.781
  5,0.8485,0.8795,0.8875
130 FOR I=1 TO 4
135 FOR J=1 TO 4
140 READ PRD(I,J)
150 NEXT J,I
200 REM TITLES
210 FOR CC=1 TO 57
220 READ A(CC)
230 NEXT CC
240 DATA GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
250 DATA Hydrocracking Report Program
260 DATA "Task 366-84-64: The Impact of Nitrogen Compounds on the"
270 DATA Processing of Synthetic Gas Oil, "Input File No.: "
280 DATA "Date of Report: ", RUN DESCRIPTION, "Date of Commencing the Run: "
290 DATA "Feed: ", "Sample No.: ", "Reference Feed: ", "Comments: "
300 DATA RUN CONDITIONS, "Pressure, MPa (psi)", "Reactor Temperature, C (F)"
305 DATA "Feed Rate, g/hr (ambient)"
310 DATA "Catalyst Volume, cc"
320 DATA "Reactor Flow Rate, std L gas per L feed"
330 DATA "Catalyst Flow Rate, std L gas per L feed"
340 DATA "Catalyst Flow Rate, std L gas per L feed"
350 DATA "Catalyst Flow Rate, std L gas per L feed"
360 DATA "Catalyst Flow Rate, std L gas per L feed"
370 DATA "Catalyst Flow Rate, std L gas per L feed"
380 DATA "Catalyst Flow Rate, std L gas per L feed"
390 DATA "Catalyst Flow Rate, std L gas per L feed"
400 DATA "Catalyst Flow Rate, std L gas per L feed"
410 DATA "Catalyst Flow Rate, std L gas per L feed"
420 DATA "Catalyst Flow Rate, std L gas per L feed"
430 DATA "Catalyst Flow Rate, std L gas per L feed"
440 DATA "Catalyst Flow Rate, std L gas per L feed"
450 DATA "Catalyst Flow Rate, std L gas per L feed"
460 DATA "Catalyst Flow Rate, std L gas per L feed"
470 DATA "Catalyst Flow Rate, std L gas per L feed"
480 DATA "Catalyst Flow Rate, std L gas per L feed"
490 DATA "Catalyst Flow Rate, std L gas per L feed"
500 DATA "Catalyst Flow Rate, std L gas per L feed"
510 DATA "Catalyst Flow Rate, std L gas per L feed"
520 DATA "Catalyst Flow Rate, std L gas per L feed"
530 DATA "Catalyst Flow Rate, std L gas per L feed"
540 DATA "Catalyst Flow Rate, std L gas per L feed"
550 DATA "Catalyst Flow Rate, std L gas per L feed"
560 DATA "Catalyst Flow Rate, std L gas per L feed"
570 DATA "Catalyst Flow Rate, std L gas per L feed"
580 DATA "Catalyst Flow Rate, std L gas per L feed"
590 DATA "Catalyst Flow Rate, std L gas per L feed"
600 DATA "Catalyst Flow Rate, std L gas per L feed"
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690 DATA "Catalyst Flow Rate, std L gas per L feed"
700 DATA "Catalyst Flow Rate, std L gas per L feed"
710 DATA "Catalyst Flow Rate, std L gas per L feed"
720 DATA "Catalyst Flow Rate, std L gas per L feed"
730 DATA "Catalyst Flow Rate, std L gas per L feed"
740 DATA "Catalyst Flow Rate, std L gas per L feed"
750 DATA "Catalyst Flow Rate, std L gas per L feed"
760 DATA "Catalyst Flow Rate, std L gas per L feed"
770 DATA "Catalyst Flow Rate, std L gas per L feed"
780 DATA "Catalyst Flow Rate, std L gas per L feed"
790 DATA "Catalyst Flow Rate, std L gas per L feed"
800 DATA "Catalyst Flow Rate, std L gas per L feed"
810 DATA "Catalyst Flow Rate, std L gas per L feed"
820 DATA "Catalyst Flow Rate, std L gas per L feed"
830 DATA "Catalyst Flow Rate, std L gas per L feed"
840 DATA "Catalyst Flow Rate, std L gas per L feed"
850 DATA "Catalyst Flow Rate, std L gas per L feed"
860 DATA "Catalyst Flow Rate, std L gas per L feed"
870 DATA "Catalyst Flow Rate, std L gas per L feed"
880 DATA "Catalyst Flow Rate, std L gas per L feed"
890 DATA "Catalyst Flow Rate, std L gas per L feed"
900 DATA "Catalyst Flow Rate, std L gas per L feed"
910 DATA "Catalyst Flow Rate, std L gas per L feed"
920 DATA "Catalyst Flow Rate, std L gas per L feed"
930 DATA "Catalyst Flow Rate, std L gas per L feed"
940 DATA "Catalyst Flow Rate, std L gas per L feed"
950 DATA "Catalyst Flow Rate, std L gas per L feed"
960 DATA "Catalyst Flow Rate, std L gas per L feed"
970 DATA "Catalyst Flow Rate, std L gas per L feed"
980 DATA "Catalyst Flow Rate, std L gas per L feed"
990 DATA "Catalyst Flow Rate, std L gas per L feed"

```

```

510 DATA "(g/cc)"
540 DATA Hydrogen, Methane, Ethane, Propane, Iso-Butane, n-Butane
550 DATA Iso-Pentane, n-Pentane, Hexanes Plus, Hydrogen Sulfide, Ammonia
560 DATA "IBP-195C Naph", "195-290C Lt D", "290-360C Hv D", "360C+ Residue"
700 PRINT CHR$(12)
710 PRINT: PRINT: PRINT: PRINT
720 PRINT "*****"
*****
730 PRINT: PRINT
740 PRINT "
750 PRINT: PRINT
760 PRINT "*****"
*****
770 PRINT: PRINT: PRINT
780 PRINT "          Writeln dv:": PRINT "
790 PRINT: PRINT: PRINT: PRINT
795 INPUT "POSITION PRINTER PAPER TO TOP OF FORM AND PRESS CARRIAGE RETURN",X$
800 INPUT "IS THIS A NEW FILE? Y/N";D$
810 IF D4="Y" THEN GOSUB 1400 ELSE 900
820 GOSUB 1620
830 GOSUB 2000
840 GOSUB 2630
850 GOTO 2110
890 REM READ INPUT DATA FROM DATA DISKETTE
900 INPUT "ENTER NAME OF OLD FILE ", NUM$
910 INPUT "INSERT DATA DISKETTE INTO DRIVE A AND PRESS CARRIAGE RETURN WHEN READ
Y",X$
920 OPEN NAME FOR INPUT AS #1
930 INPUT #1, K0$IF, D0$IF, FTYPE$, SNO1$, RFTYPE$
940 INPUT #1, CORR#
950 INPUT #1, F1, I1, F0$IF, CATVOL, HZRATE, NDAYS
960 FOR I=1 TO NDAYS
970 INPUT #1, DRUG(I), FEEDVOL(I), FEEDDISC(I), FEEDDENS(I), LPRODWT(I),
FLPDENS(I), FLPDISC(I), SGVOL(I), SGT(I), SGP(I)
980 FOR K=1 TO I
990 INPUT #1, SGAC(I,K), GDC(I,K)
1000 NEXT K
1010 FOR K=1 TO 3
1020 INPUT #1, ARON(I,K)
1022 NEXT K
1024 FOR K=1 TO 3 STEP 2
1026 INPUT #1, NS(I,K)
1030 NEXT K
1040 FOR I=1 TO 11
1050 INPUT #1, L0(I), L1(I), L2(I), L3(I), L4(I), L5(I), L6(I), L7(I), L8(I), L9(I)
1060 NEXT I
1070 FOR I=1 TO
1080 INPUT #1, L0(I), L1(I), L2(I), L3(I), L4(I), L5(I), L6(I), L7(I), L8(I), L9(I)
1090 NEXT I

```

J. G. Spiro, April 1985"

HYDROCRACKING REPORT PROGRAM"

```

1110 GOTO 2110
1390 REM SUBROUTINE: INPUT FILE NO., DATE OF REPORT, RUN DESCRIPTION, RUN CON-
DITIONS
1400 INPUT "INPUT FILE NO.":NUM1
1500 INPUT "DATE OF REPORT":RDATE$
1510 INPUT "DATE OF COMMENCING THE RUN":DATE$
1520 INPUT "FEED TYPE"
1530 INPUT "FEED SAMPLE NO.":SND1$
1540 INPUT "REFERENCE FEED":REF1$
1560 INPUT "COMMENTS:COMM$
1570 INPUT "REACTOR PRESSURE, MPa":P1
1580 INPUT "REACTOR TEMPERATURE, °C":T1
1590 INPUT "FEED FLOW RATE, cc/hr":FEEDF
1600 INPUT "TOTAL GAS VOLUME, cc":GASVOL
1610 INPUT "TOTAL FLOW RATE, STD L/L FEED":FLOWRATE
1620 GOTO 1620
1630 END
1640 END
1650 REM SUBROUTINE: INPUT FEED AND STABILIZER GAS DATA FOR EACH RUN. SPECIAL
CODES EMPLOYED FOR EDITING.
1660 INPUT "NUMBER OF DAYS":NDAYS$
1670 IF LEN(NDAYS$) > 1 THEN GOTO 1626
1680 NDAYS=VAL(NDAYS$)
1690 SAYEND=NDAYS
1700 GOTO 1700
1710 GOTO 1710
1720 REM "DAY X":DAYX=NDAYS
1730 REM "FEED VOLUME, cc":FEEDVOL(I)
1740 REM "FEED DENSITY AT 15C, g/cc":FEEDD15C(I)
1750 REM "FEED DENSITY AT AMBIENT CONDITIONS, g/cc":FEEDDENS(I)
1760 REM "TLP MEASUREMENT":TLPMEAS(I)
1770 REM "TLP DENSITY AT AMBIENT CONDITIONS AND 15C, g/cc":TLPDENS(I),
TLPD15C(I)
1780 INPUT "STABILIZER GAS VOLUME, L":SGVOL(I)
1790 INPUT "AIR FLOW Y ANALYSIS":SGF(I)
1800 INPUT "STABILIZER GAS ANALYSIS, H2, O2, CO, C3, 1C4, nC4, iC5, nC5, C6+,
H2S, NH3":SGA(I,1),SGA(I,2),SGA(I,3),SGA(I,4),SGA(I,5),SGA(I,6),SGA(I,7),
SGA(I,8),SGA(I,9),SGA(I,10),SGA(I,11)
1810 IF LEN(SGA(I,1)) > 1 THEN INPUT "DO YOU WISH TO EDIT PRODUCT INSPECTIONS? Y/N":
1820 GOTO 1820
1830 GOTO 1830
1840 GOTO 1840
1850 GOTO 1850
1860 GOTO 1860
1870 GOTO 1870
1880 GOTO 1880
1890 GOTO 1890
1900 GOTO 1900
1910 GOTO 1910
1920 GOTO 1920
1930 GOTO 1930
1940 GOTO 1940
1950 GOTO 1950
1960 GOTO 1960
1970 GOTO 1970
1980 GOTO 1980
1990 GOTO 1990
2000 GOTO 2000
2010 GOTO 2010
2020 GOTO 2020
2030 GOTO 2030
2040 GOTO 2040
2050 GOTO 2050
2060 GOTO 2060
2070 GOTO 2070
2080 GOTO 2080
2090 GOTO 2090
2100 GOTO 2100
2110 GOTO 2110
2120 GOTO 2120
2130 GOTO 2130
2140 GOTO 2140
2150 GOTO 2150
2160 GOTO 2160
2170 GOTO 2170
2180 GOTO 2180
2190 GOTO 2190
2200 GOTO 2200
2210 GOTO 2210
2220 GOTO 2220
2230 GOTO 2230
2240 GOTO 2240
2250 GOTO 2250
2260 GOTO 2260
2270 GOTO 2270
2280 GOTO 2280
2290 GOTO 2290
2300 GOTO 2300
2310 GOTO 2310
2320 GOTO 2320
2330 GOTO 2330
2340 GOTO 2340
2350 GOTO 2350
2360 GOTO 2360
2370 GOTO 2370
2380 GOTO 2380
2390 GOTO 2390
2400 GOTO 2400
2410 GOTO 2410
2420 GOTO 2420
2430 GOTO 2430
2440 GOTO 2440
2450 GOTO 2450
2460 GOTO 2460
2470 GOTO 2470
2480 GOTO 2480
2490 GOTO 2490
2500 GOTO 2500
2510 GOTO 2510
2520 GOTO 2520
2530 GOTO 2530
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2570 GOTO 2570
2580 GOTO 2580
2590 GOTO 2590
2600 GOTO 2600
2610 GOTO 2610
2620 GOTO 2620
2630 GOTO 2630
2640 GOTO 2640
2650 GOTO 2650
2660 GOTO 2660
2670 GOTO 2670
2680 GOTO 2680
2690 GOTO 2690
2700 GOTO 2700
2710 GOTO 2710
2720 GOTO 2720
2730 GOTO 2730
2740 GOTO 2740
2750 GOTO 2750
2760 GOTO 2760
2770 GOTO 2770
2780 GOTO 2780
2790 GOTO 2790
2800 GOTO 2800
2810 GOTO 2810
2820 GOTO 2820
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2870 GOTO 2870
2880 GOTO 2880
2890 GOTO 2890
2900 GOTO 2900
2910 GOTO 2910
2920 GOTO 2920
2930 GOTO 2930
2940 GOTO 2940
2950 GOTO 2950
2960 GOTO 2960
2970 GOTO 2970
2980 GOTO 2980
2990 GOTO 2990
3000 GOTO 3000
3010 GOTO 3010
3020 GOTO 3020
3030 GOTO 3030
3040 GOTO 3040
3050 GOTO 3050
3060 GOTO 3060
3070 GOTO 3070
3080 GOTO 3080
3090 GOTO 3090
3100 GOTO 3100
3110 GOTO 3110
3120 GOTO 3110
3130 GOTO 3110
3140 GOTO 3110
3150 GOTO 3110
3160 GOTO 3110
3170 GOTO 3110
3180 GOTO 3110
3190 GOTO 3110
3200 GOTO 3110
3210 GOTO 3110
3220 GOTO 3110
3230 GOTO 3110
3240 GOTO 3110
3250 GOTO 3110
3260 GOTO 3110
3270 GOTO 3110
3280 GOTO 3110
3290 GOTO 3110
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3390 GOTO 3110
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3480 GOTO 3110
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3580 GOTO 3110
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3970 GOTO 3110
3980 GOTO 3110
3990 GOTO 3110
4000 GOTO 3110
4010 GOTO 3110
4020 GOTO 3110
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4050 GOTO 3110
4060 GOTO 3110
4070 GOTO 3110
4080 GOTO 3110
4090 GOTO 3110
4100 GOTO 3110
4110 GOTO 3110
4120 GOTO 3110
4130 GOTO 3110
4140 GOTO 3110
4150 GOTO 3110
4160 GOTO 3110
4170 GOTO 3110
4180 GOTO 3110
4190 GOTO 3110
4200 GOTO 3110
4210 GOTO 3110
4220 GOTO 3110
4230 GOTO 3110
4240 GOTO 3110
4250 GOTO 3110
4260 GOTO 3110
4270 GOTO 3110
4280 GOTO 3110
4290 GOTO 3110
4300 GOTO 3110
4310 GOTO 3110
4320 GOTO 3110
4330 GOTO 3110
4340 GOTO 3110
4350 GOTO 3110
4360 GOTO 3110
4370 GOTO 3110
4380 GOTO 3110
4390 GOTO 3110
4400 GOTO 3110
4410 GOTO 3110
4420 GOTO 3110
4430 GOTO 3110
4440 GOTO 3110
4450 GOTO 3110
4460 GOTO 3110
4470 GOTO 3110
4480 GOTO 3110
4490 GOTO 3110
4500 GOTO 3110
4510 GOTO 3110
4520 GOTO 3110
4530 GOTO 3110
4540 GOTO 3110
4550 GOTO 3110
4560 GOTO 3110
4570 GOTO 3110
4580 GOTO 3110
4590 GOTO 3110
4600 GOTO 3110
4610 GOTO 3110
4620 GOTO 3110
4630 GOTO
```

```

1930 INPUT "PRODUCT TOTAL N, TOTAL S, ppm w/w";NS(I,1), NS(I,3)
1960 NEXT I
1961 NDAYS=SAVEND
1962 RETURN
1963 END
1970 REM FEED AND REFERENCE FEED INPUT DATA
1990 REM SUBROUTINE: INPUT FEED INSPECTIONS
2000 INPUT "FEED GCD: IBP, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, FBP (C)"
; FGCD(1),FGCD(2),FGCD(3),FGCD(4),FGCD(5),FGCD(6),FGCD(7),FGCD(8),FGCD(9),FGCD
(10),FGCD(11)
2010 INPUT "FEED UV-AROMATICS, Mole% Mono, Di, PNA";FAROM(1),FAROM(2),FAROM(3)
2020 INPUT "FEED TOTAL N, BASIC N, TOTAL S, ppm w/w";FEEDNS(1),FEEDNS(2),FEEDNS(
3)
2022 RETURN
2023 END
2029 REM SUBROUTINE: INPUT REFERENCE FEED INSPECTIONS
2030 INPUT "REFERENCE FEED GCD: IBP, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%
, FBP (C)";RFGCD(1),RFGCD(2),RFGCD(3),RFGCD(4),RFGCD(5),RFGCD(6),RFGCD(7),RFGCD
(8),RFGCD(9),RFGCD(10),RFGCD(11)
2055 INPUT "REFERENCE FEED UV-AROMATICS, Mole% Mono, Di, PNA";RFAROM(1),RFAROM(
2),RFAROM(3)
2065 INPUT "REFERENCE FEED TOTAL N, BASIC N, TOTAL S, ppm w/w";RFENS(1),RFENS(2),
RFENS(3)
2070 RETURN
2071 END
2100 REM CHECK THAT STABILIZER GAS COMPONENTS ADD UP TO 100% FOR EACH RUN
2110 FOR I=1 TO NDAYS
2120 SUM(1)=0
2130 FOR K=1 TO 11
2140 SUM(1)=SUM(1)+GAS(I,K)
2150 NEXT K
2160 NEXT I
2170 PRINT CHR$(12)
2180 FOR I=1 TO NDAYS
2185 PRINT UNIT(I); " STABILIZER GAS COMPONENTS SUM TO ";
2190 PRINT USING "###.##"; SUM(1)
2200 NEXT I
2205 INPUT "PRESS CONTROL RETURN KEY TO CONTINUE", X$
2210 REM GO INTO EDITING ROUTINE
2220 GOTO 9010
3000 REM INPUT DATA SHEET
3010 REM (PRINT TITLE, FILE NO., DATE OF REPORT
3014 LPRINT: LPRINT
3020 FOR I=1 TO 4
3030 LPRINT: LPRINT: LPRINT
3040 NEXT I
3050 LPRINT: LPRINT: LPRINT
3060 NEXT I
3070 LPRINT: LPRINT: LPRINT
3080 NEXT I
3090 LPRINT: LPRINT: LPRINT
3100 NEXT I
3110 LPRINT: LPRINT: LPRINT
3120 NEXT I
3130 LPRINT: LPRINT: LPRINT
3140 NEXT I
3150 LPRINT: LPRINT: LPRINT
3160 NEXT I
3170 LPRINT: LPRINT: LPRINT
3180 NEXT I
3190 LPRINT: LPRINT: LPRINT
3200 NEXT I
3210 LPRINT: LPRINT: LPRINT
3220 NEXT I
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3240 NEXT I
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3260 NEXT I
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3380 NEXT I
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3400 NEXT I
3410 LPRINT: LPRINT: LPRINT
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3430 LPRINT: LPRINT: LPRINT
3440 NEXT I
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3870 LPRINT: LPRINT: LPRINT
3880 NEXT I
3890 LPRINT: LPRINT: LPRINT
3900 NEXT I
3910 LPRINT: LPRINT: LPRINT
3920 NEXT I
3930 LPRINT: LPRINT: LPRINT
3940 NEXT I
3950 LPRINT: LPRINT: LPRINT
3960 NEXT I
3970 LPRINT: LPRINT: LPRINT
3980 NEXT I
3990 LPRINT: LPRINT: LPRINT
4000 NEXT I

```



```

3060 IF OUTFLAG=1 THEN 3067
3065 LPRINT TAB(29); CHR$(14); "INPUT DATA*"; CHR$(20)
3066 GOTO 3070
3067 LPRINT TAB(19); CHR$(14); "HYDROCRACKING REPORT*"; CHR$(20)
3070 LPRINT LPRINT
3070 LPRINT TAB(7) A$(7)
3080 LPRINT TAB(9) A$(8); DAT$
3090 LPRINT TAB(9) A$(9); FTYPE$; A$(10); SNOI$
3100 LPRINT TAB(9) A$(11); NTYPE$
3110 LPRINT TAB(9) A$(12); COMM$
3120 LPRINT TAB(9) A$(13)
3130 LPRINT: LPRINT TAB(7) A$(13)
3140 P2=145.04*P1
3150 LPRINT TAB(9) A$(14); TAB(36) P1; TAB(43) " ";
3155 LPRINT USING "###.#"; P2;
3156 LPRINT " "
3160 T2=32 + 1.8*F1
3170 LPRINT TAB(9) A$(15); TAB(36) T1; TAB(43) " ";
3173 LPRINT USING "###"; T2;
3176 LPRINT " "
3178 LPRINT TAB(9) A$(16); TAB(36) FRATE
3180 LPRINT TAB(9) A$(17); TAB(36) CATVOL
3210 LPRINT TAB(9) A$(18); TAB(51) HZRATE
3215 IF OUTFLAG=1 THEN GOTO 5000
3219 REM LPRINT STABILIZER GAS ANALYSES AND "MISCELLANEOUS" INPUT DATA
3220 LPRINT
3225 LPRINT TAB(7) "STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA"
3230 LPRINT TAB(44);
3235 GOSUB 3240
3237 GOTO 3280
3238 REM SUBROUTINE: LPRINT DAY X HEADINGS
3240 LPRINT " ";
3242 FOR I=1 TO NDAY$
3250 LPRINT " "; INU$(I);
3260 NEXT I
3262 LPRINT TAB(44);
3264 FOR I=1 TO NDAY$
3265 IF I=NDAYS THEN 3268
3266 LPRINT " ";
3267 GOTO 3269
3268 LPRINT " (Net Run)"
3269 NEXT I
3275 LPRINT: RETURN
3278 END
3280 LPRINT: LPRINT TAB(7) "Total Volume, (L Ambient)"; TAB(45) I
3290 FOR I=1 TO 10000
3300 LPRINT " "
3310 IF I=1
3320 LPRINT "Total Volume, (L Ambient)"; TAB(45) I
3330 FOR I=1 TO 10000

```

[illegible]

```

3840 FOR K=1 TO NDAYS
3860 LPRINT USING "    ##      "; GCD(K,I);
3870 NEXT K
3880 NEXT I
3890 LPRINT: LPRINT: LPRINT TAB(9) A$(34)
3900 LPRINT TAB(29);
3905 LPRINT A$(21); A1(22);
3907 GO SUB 3240
3910 FOR I=1 TO 3
3920 J=I + 34
3930 LPRINT TAB(11) A$(J); "    ";
3940 LPRINT USING "##.##"      "; PARABOL(I);
3945 LPRINT "    ";
3944 LPRINT USING "##.##"      "; KEARNEY(I);
3950 FOR F=1 TO NDAYS
3970 LPRINT USING "    ##.##"   "; ARON(I,F);
3980 NEXT F
3990 NEXT I
4010 FOR I=1 TO 3
4020 J=I + 37
4030 LPRINT TAB(11) A$(J);
4040 LPRINT USING "    #####"
4045 LPRINT "    ";
4044 LPRINT USING "    #####"
4050 FOR F=1 TO NDAYS
4060 IF F=2 THEN GO TO 4075
4070 LPRINT USING "    ##.#"    "; NS(F,I);
4071 GO TO 4080
4075 LPRINT "        R.A.*";
4080 NEXT F
4090 NEXT I
4091 LPRINT TAB(9) A1(41);
4092 LPRINT USING "    ####"
4093 LPRINT "    ";
4094 FOR F=1 TO NDAYS
4095 LPRINT USING "    ####"    "; ILPD15C(K);
4097 NEXT F
4098 LPRINT TAB(15) A1(42)
4099 IF OUTFLAG=1 THEN GO TO 5900
4100 LPRINT: LPRINT: LPRINT TAB(9) "Fraction Densities at 15C, g/cc"
4102 LPRINT TAB(30) A1(21); A1(22); "    "; DNO$(1); "    "; DNO$(NDAYS)
4104 LPRINT TAB(50) "(K+1-K00)"
4110 FOR I=1 TO 4
4120 J=I + 53
4130 LPRINT TAB(11) A$(J); TAB(29);
4140 LPRINT USING "    #.####"
4141 LPRINT USING "    #.####"

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4193 LPRINT:LPRINT:LPRINT
4194 IF I=2 THEN LPRINT TAB(7) " * N.A.-Not Available - expected to be below the
detection limit of 30 ppm"
4195 NEXT I
4197 GOTO 9060
5000 REM YIELD CALCULATIONS FOR THE REPORT, PRINT AND LPRINT OVERALL YIELDS
5002 REM VOLUME FRACTIONS OF NAPHTHA, LIGHT DISTILLATE, ETC ONLY CALCULATED IN
THIS SEGMENT OF THE PROGRAM, WITH THE HARD COPY PRINTED AT LINE 5900.
5005 FOR J=1 TO 11
5006 Y(J)=10*(J-1)
5010 NEXT J
5015 FOR I=1 TO 10000
5016 LPRINT:FEEDW(1)*FEEDDENS(1)
5017 FOR L=1 TO 4:FEEDW(L)*FEEDDENS(L)/ATLDCW(1)*ATLDPENS(L)
5018 IF L=4 THEN L=1 ELSE L=L+1
5020 LPRINT:VOL(1)=VOL(1)+FEEDW(1)/FEEDWT
5030 LPRINT:VOL(L)=VOL(1)+FEEDW(L)/ATLDPENS(L)*FEEDW(1)
5040 SUM=0
5045 REM WEIGHT OF HYDROCARBONS IN THE OVERHEAD GAS
5050 FOR L=2 TO 9
5060 SUM=SUM + SUMVOL(L)*DEN(L)
5070 NEXT L
5075 EXTRASUM=SUM(1,10)*DEN(10) + SUM(1,11)*DEN(11)
5080 VOL(1)=SUMVOL(1)*SUM(1)*2/5.16/(50*(SUM(1) + 273.16))
5090 OVERW(1)=VOL(1)*SUM(1)*FEEDWT
5095 EXTRAW(1)=VOLUME*EXTRASUM/FEEDWT
5100 TOT(1)=VOL(1)+OVERW(1) + OVERW(1) + EXTRAW(1)
5110 TOTREL(1)=(TOT(1)+VOL(1)+OVERW(1))/ATLDPENS(1) + VOLUME*(SUM(1) + EXTRASUM/.79))/
FEEDW(1)
5120 FOR L=10 TO 11 VOL(1)=FRACTIONS BOILING UP TO 195, 290 AND 360C
5130 FOR J=1 TO 11
5140 X(J)=VOL(L,J)
5150 NEXT J
5160 GOSUB 8040
5170 XINT=195
5180 GOSUB 8530
5185 COMP1=YINT/PROD(1,1)
5190 NAPHTH(1)=FAC*100*COMP1
5195 SAVEINT=YINT
5200 XINT=290
5210 GOSUB 8530
5215 COMP2=YINT/SAVEINT/PROD(1,2)
5220 LOST(1)=FAC*100*COMP2
5230 SAVEINT=YINT
5240 XINT=360
5250 GOSUB 8530
5255 COMP3=YINT/SAVEINT/PROD(1,3)
5260 LOST(1)=FAC*100*COMP3
5265 LOST(1)=FAC*100*COMP3

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5274 NAPHVPC(I)=CORRECTN*NAPHVPC(I)
5275 LDSTVPC(I)=CORRECTN*LDSTVPC(I)
5276 HDSTVPC(I)=CORRECTN*HDSTVPC(I)
5277 RESVPC(I)=CORRECTN*RESVPC(I)
5280 OVHCWPC(I)=OVHCW(I)*FEEDD15C(I)/.52
5290 NEXT I
5300 REM CALCULATE FEED AND REFERENCE FEED DISTRIBUTIONS FROM GCD-S
5310 FOR J=1 TO 11
5320 X(J)=FGCD(J)
5330 NEXT J
5340 GOSUB B040
5350 XINT=290
5360 GOSUB B530
5410 FEEDLDFC=FEEDD15C(I)*YINT/PRODD(1,2)
5420 SAVEINT=YINT
5430 XINT=360
5440 GOSUB B530
5450 FEEDHDFC=FEEDD15C(I)*(YINT - SAVEINT)/PRODD(1,3)
5460 FEEDRPL=FEEDD15C(I)*(100-YINT)/PRODD(1,4)
5470 FOR J=1 TO 11
5480 X(J)=RFGCD(J)
5490 NEXT J
5500 GOSUB B040
5510 XINT=290
5520 GOSUB B530
5530 RFDLDFC=FEEDD15C(NDAYS)*YINT/PRODD(2,2)
5540 SAVEINT=YINT
5550 XINT=360
5560 GOSUB B530
5570 RFDHDFC=FEEDD15C(NDAYS)*(YINT - SAVEINT)/PRODD(2,3)
5580 RFDLPL=FEEDD15C(NDAYS)*(100-YINT)/PRODD(2,4)
5590 PRINT CHR$(12)
5600 FOR I=1 TO NDAYS
5610 PRINT "LIO REC, wt%", LIOREC(I), "vol%", LIORECV(I), "GAS, wt% ", OVHCW(I)
5620 PRINT "TOT PROD REC, wt%", TOTPRECW(I), "vol%", TOTPRECV(I)
5625 NEXT I
5630 INPUT "ARE THESE RESULTS WORTH PRINTING OUT? Y/N";X#
5640 IF X#="N" THEN GOTO 5010
5645 REM PRINT OUT OVERALL YIELDS
5650 LPRINT: LPRINT TAB(7) "OVERALL YIELDS"
5660 LPRINT TAB(44);
5670 GOSUB B340
5680 LPRINT TAB(9) "Liquid Recovery, wt%"; TAB(45);
5690 FOR I=1 TO NDAYS
5700 LPRINT "L LIO, " 800.#;"L LIOREC(I);
5710 LPRINT "L LIO, " 800.#;"L LIORECV(I);
5720 LPRINT "L LIO, " 800.#;"L LIOREC(I);
5730 LPRINT "L LIO, " 800.#;"L LIORECV(I);

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5770 FOR I=1 TO NDAYS
5780 LPRINT USING "      ##.##";OVHCW(I);
5790 NEXT I
5800 LPRINT TAB(9) "Total Prod. Recovery, wt%"; TAB(45);
5810 FOR I=1 TO NDAYS
5820 LPRINT USING "      ##.##"; TOTPRECW(I);
5830 NEXT I
5840 LPRINT TAB(9) "Total Prod. Recovery, vol%"; TAB(45);
5850 FOR I=1 TO NDAYS
5860 LPRINT USING "      ##.##"; TOTPRECV(I);
5870 NEXT I
5872 FOR I=1 TO 6
5873 LPRINT: LPRINT: LPRINT
5874 IF I=1 THEN LPRINT TAB(7) "*Includes hydrogen sulfide and ammonia in the overhead gas"
5876 NEXT I
5877 LPRINT: LPRINT
5880 GOTO 3760
5890 REM PRINT OUT INDIVIDUAL PRODUCT YIELDS
5900 LPRINT: LPRINT
5905 LPRINT TAB(7) "INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C"
5910 LPRINT: LPRINT TAB(28) A$(21); A$(22);
5920 GOSUB 3240
5930 LPRINT TAB(9) "Light Ends (Gas)";
5940 LPRINT TAB(30) "-"; TAB(40) "-";TAB(51);
5950 FOR I=1 TO NDAYS
5960 LPRINT USING "##.##" ";OVHCVPC(I);
5970 NEXT I
5980 LPRINT TAB(9) "IBP 195C Naph";
5990 LPRINT TAB(30) "-"; TAB(40) "-"; TAB(51);
6000 FOR I=1 TO NDAYS
6010 LPRINT USING "##.##" ";NAFHVPC(I);
6020 NEXT I
6030 LPRINT TAB(9) "195-290C L1 D";
6033 LPRINT USING "##.##"; FEEDLDPC; RFDLDPC;
6034 LPRINT " ";
6035 FOR I=1 TO NDAYS
6040 LPRINT USING "##.##" "; LDS1VPC(I);
6050 NEXT I
6060 LPRINT TAB(9) "290-360C HV D";
6065 LPRINT USING "##.##"; FEEDHDPC; RFDHDPC;
6067 LPRINT " ";
6070 FOR I=1 TO NDAYS
6080 LPRINT USING "##.##" "; HDS1VPC(I);
6090 NEXT I
6100 LPRINT TAB(9) "360-460C F2 D";
6105 LPRINT USING "##.##"; FEEDF2PC; RFDNFPC;
6107 LPRINT " ";

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6133 LPRINT:LPRINT TAB(7) "*" Hydrocarbons only, i.e. hydrogen sulfide and
    ammonia are not included"
6490 REM SAVE OUTPUT ON DATA DISKETTE IF DESIRED
6500 INPUT "DO YOU WISH TO SAVE THE OUTPUT ON DISK? Y/N"; S$
6510 IF S$="N" THEN GOTO 6736
6520 INPUT "OUTPUT FILE NO."; NUMOUT$
6530 INPUT "INSERT DATA DISKETTE INTO DRIVE A AND PRESS CARRIAGE RETURN WHEN REA
    DY", X$
6540 OPEN NUMOUT$ FOR OUTPUT AS #1
6550 WRITE #1, NUM$; RDATE$; DATE$; FTYPE$; SNO1$; RTYPE$
6560 WRITE #1, COMM$
6570 WRITE #1, P1; I1; FRATE; CALVOL; IZERATE; NDAYS
6580 FOR I=1 TO NDAYS
6590 WRITE #1, DNO$(); IORECW(I); LDSTVPC(I); HDSTVPC(I); RESVPC(I); OVHCVPC(I);
    LFD15C(I)
6600 FOR K=1 TO 11
6610 WRITE #1, GCD(I,K)
6620 NEXT K
6630 FOR K=1 TO 3
6640 WRITE #1, ARUM(I,K)
6650 NEXT K
6652 FOR K=1 TO 3 STEP 2
6655 WRITE #1, NS(I,K)
6657 NEXT K
6660 WRITE #1, NAPHVPC(I); LDSTVPC(I); HDSTVPC(I); RESVPC(I); OVHCVPC(I)
6665 NEXT I
6670 FOR K=1 TO 11
6680 WRITE #1, FGCD(K); RFGCD(K)
6690 NEXT K
6700 FOR K=1 TO 3
6710 WRITE #1, FARUM(K); RFARUM(K); RFNS(K)
6715 NEXT K
6717 WRITE #1, FEEDD15C(I); FEEDD15C(NDAYS)
6718 WRITE #1, FEEDLDPC; RFDLDPC; FEEDHDPC; RFDHDPC; FEEDRPC; RFDRPC
6720 CLOSE #1
6736 FOR I=1 TO 4
6738 LPRINT: LPRINT: LPRINT
6739 IF I=1 AND S$="Y" THEN LPRINT TAB(7) "Output File No.: "; NUMOUT$
6740 NEXT I
6750 END: REM END OF PROGRAM EXECUTION
6752 REM ***** END *****
6754 REM *****
7000 REM SAVE CURRENT INPUT DATA ON DISK
7005 INPUT "INSERT DATA DISKETTE INTO DRIVE A AND PRESS CARRIAGE RETURN WHEN
    READY", X$
7010 OPEN NUM$ FOR OUTPUT AS #1
7020 WRITE #1, DDATE$; DATE$; FTYPE$; SNO1$; RTYPE$
7030 WRITE #1, COMM$
7040 WRITE #1, P1; I1; FRATE; CALVOL; IZERATE; NDAYS

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TLPDENS(I); TLPDISC(I); SGVUL(I); SGI(I); SGP(I)
7070 FOR K=1 TO 11
7080 WRITE #1, SGAL(K); GCD(I,K)
7090 NEXT K
7100 FOR K=1 TO 3
7110 WRITE #1, AROM(I,K)
7111 NEXT K
7112 FOR K=1 TO 3 STEP 2
7114 WRITE #1, NS(I,K)
7160 NEXT K,I
7170 FOR F=1 TO 11
7180 WRITE #1, FRD(F); RFGCD(K)
7190 NEXT F
7200 FOR F=1 TO 3
7210 WRITE #1, FAROM(F); FEEDNS(K); RFAROM(K); RFNS(K)
7220 NEXT F
7221 FOR I=1 TO 4
7222 FOR K=1 TO 4
7223 WRITE #1, FRODD(I,K)
7224 NEXT K,I
7225 CLOSE #1
7230 GOTO 9080
8000 REM SUBROUTINE: CALCULATES SPLINE FORMULA COEFFICIENTS FOR 11 POINTS.
8010 REM SOURCE: RALPH H PENNINGTON, "INTRODUCTORY COMPUTER METHODS AND
      NUMERICAL ANALYSIS", MACMILLAN, 1968.
8021 REM
8022 REM ** NOTE: DIMENSION STATEMENT MUST BE PULLED UP FRONT BEFORE EXECUTION**
8023 REM
8040 FOR F=1 TO 10
8050 D(F)=X(F+1) - X(F)
8060 P(F)=D(F)/6
8070 E(F)=(Y(F+1) - Y(F))/D(F)
8080 NEXT F
8090 FOR K=2 TO 10
8100 B(F)=E(F) - E(F-1)
8110 NEXT K
8120 A(1,2)=-1 - D(1)/D(2)
8130 A(1,3)=D(1)/D(2)
8140 A(2,3)=P(2) - P(1)*A(1,3)
8143 A(2,2)=2*(P(1)+P(2)) - P(1)*A(1,2)
8146 A(2,3)=A(2,3)/A(2,2)
8150 B(2)=B(2)/A(2,2)
8160 FOR F=3 TO 10
8170 A(F,2)=2*(P(F-1)+P(F)) - P(F-1)*A(F-1,3)
8180 B(F)=B(F) - P(F-1)*B(F-1)
8190 A(F,3)=P(F)+P(F-1)*A(F-1,2)
8200 B(F)=B(F)+P(F-1)*B(F-1)
8210 NEXT F

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8250 B(11)=B(9) - A(11,1)*B(10)
8260 Z(11)=B(11)/A(11,2)
8270 FOR I1=1 TO 9
8280 K=11-I1
8290 Z(K)=B(K) - A(K,3)*Z(K+1)
8300 NEXT I1
8310 Z(1)=-A(1,2)*Z(2) - A(1,3)*Z(3)
8320 FOR K=1 TO 10
8330 Q=1/(6*D(K))
8340 C(1,K)=Z(K)*Q
8350 C(2,K)=Z(K+1)*Q
8360 C(3,K)=Y(K)/D(K) - Z(K)*P(K)
8370 C(4,K)=Y(K+1)/D(K) - Z(K+1)*P(K)
8380 NEXT K
8390 RETURN
8400 END
8410 REM SUBROUTINE: FOR SPLINE FIT INTERPOLATION, 11 PAIRS OF VALUES INPUT.
8420 REM SOURCE: KATHY H PENNINGTON, "INTRODUCTORY COMPUTER METHODS AND
NUMERICAL ANALYSIS", MACMILLAN, 1968.
8430 IF XINT<X(1) THEN GOTO 8800
8440 IF XINT>X(1) THEN GOTO 8570
8450 YINT=Y(1)
8460 RETURN
8470 K=1
8480 IF XINT-X(K+1) THEN GOTO 8630
8490 IF XINT>X(K+1) THEN GOTO 8620
8500 YINT=Y(K+1)
8510 RETURN
8520 I=I+1
8530 IF K=11 THEN GOTO 8580 ELSE GOTO 8800
8540 YINT=(X(K+1)-XINT)*(C(1,K)*(X(K+1)-XINT)^2 + C(3,K))
8550 YINT=YINT + (XINT-X(K))*(C(2,K)*(XINT-X(K))^2 + C(4,K))
8560 RETURN
8570 PRINT CHR$(12)
8580 PRINT "INDEPENDENT VARIABLE OUT OF RANGE FOR INTERPOLATION"
8590 END
9000 REM EDITING ROUTINE
9010 PRINT CHR$(12)
9020 INPUT "DO YOU WISH TO EDIT THE CURRENT INPUT DATA? Y/N";E$
9030 IF E$="N" THEN OUTFLAG=1: GOTO 3014
9040 INPUT "DO YOU WISH TO HAVE A HARD COPY OF THE CURRENT INPUT DATA? Y/N";H$
9050 IF H$="Y" THEN OUTFLAG=0: GOTO 3014
9060 INPUT "DO YOU WISH TO SAVE THE CURRENT INPUT DATA ON DISK - BEFORE EDITING
IT? Y/N";S$
9070 IF S$="Y" THEN GOTO 2005
9080 INPUT "DO YOU WISH TO EDIT THE TITLE, RUN DESCRIPTION OR RUN CONDITIONS?
Y/N";I$
9090 IF I$="Y" THEN GOTO 1000
9100 PRINT CHR$(12);
9110 INPUT "DO YOU WISH TO EDIT THE DATA FOR AN INDIVIDUAL RUN?

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9120 PRINT "*** IN RESPONSE TO THE NEXT PROMPT (NUMBER OF DAYS?), INPUT"
9130 PRINT "1ST, 2ND OR 3RD - ACCORDING TO WHICH RUN YOU WISH TO EDIT"
9140 GOSUB 1620
9150 GOTO 9100
9160 PRINT CHR\$(12): INPUT "DO YOU WISH TO EDIT THE FEED INPUT DATA? Y/N";F\$
9170 IF F\$="Y" THEN GOSUB 2000
9180 PRINT CHR\$(12): INPUT "DO YOU WISH TO EDIT THE REFERENCE FEED INPUT DATA? Y
/N";RF\$
9190 IF RF\$="Y" THEN GOSUB 2030
9200 GOTO 2110

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: M2-3APR23
Date of Report: 1985-04-27

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-03-05
Feed: SUNCOR GAS OIL + SYNCRUDE EXTRACT Sample No.: MR-2-EXP-C
Reference Feed: SFW SYNCRUDE GAS OIL
Comments: REACTOR PLUGGING PROBLEMS

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.62
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	Day 5	Day 8	Day 10 (Ref Run)
Feed Volume, cc (ambient)	103.00	107.00	103.50
Feed Density at 15C	0.9584	0.9584	0.9344
Feed Density, g/cc (ambient)	0.9534	0.9534	0.9299
Total Liquid Product, g	96.98	100.23	96.54
TLP Density at 15C	0.8772	0.8850	0.8680
TLP Density, g/cc (ambient)	0.8726	0.8804	0.8630
Stabilizer Gas Volume, L	117.60	122.81	119.55
Temperature, C	23.5	26.0	29.0
Pressure, mm Hg	750	750	750

Stabilizer Gas Analyses, mole% on air- and water-free basis

	Day 5	Day 8	Day 10
Hydrogen	98.02	98.93	99.47
Methane	0.41	0.30	0.18
Ethane	0.26	0.00	0.06
Propane	0.25	0.15	0.17
Isobutane	0.11	0.05	0.07
n-Butane	0.00	0.00	0.00
Isopentane	0.07	0.06	0.00
n-Pentane	0.00	0.00	0.00
Hexanes Plus	0.00	0.00	0.00
Hydrogen Sulfide	0.95	0.50	0.09
Ammonia	0.00	0.00	0.00

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FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	Day 5	Day 9	Day 10 (Ref Run)
IBP	125	205	44	34	47
10%	286	289	159	168	162
20%	311	321	237	234	227
30%	331	344	264	273	270
40%	349	362	292	299	299
50%	368	379	313	320	325
60%	387	395	335	342	349
70%	408	417	359	367	372
80%	432	441	389	396	400
90%	464	473	433	440	447
FBP	555	572	555	562	549

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	Day 5	Day 9	Day 10 (Ref Run)
Monoaromatics	29.10	41.72	44.97	46.95	14.45
Diaromatics	13.50	9.60	1.54	3.67	0.51
PNA-s	12.70	6.22	0.88	2.25	0.13
Total N	1934	963	3.9	11.7	1.6
Basic N	739	200	N.A.*	N.A.*	N.A.*
Total S	14200	1500	235.0	931.0	370.0
Densities @ 15C (g/cc)	.9594	.9344	.8772	.9850	.9580

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	Day 5	Day 10 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8700	0.8500	0.8485	0.8485
290-360C Hv D	0.9200	0.9000	0.8795	0.8795
360C+ Residue	1.0059	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 70 ppm

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-94-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: M2-3AP523
Date of Report: 1985-04-27

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-07-05
Feed: SUNCOR GAS OIL + SYNCRUDE EXTRACT Sample No.: MR-2-EXP-7
Reference Feed: RAW SYNCRUDE GAS OIL
Comments: REACTOR PLUGGING PROBLEMS

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.62
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	Day 5	Day 9	Day 10 (Ref Run)
Liquid Recovery, wt%	98.8	98.7	100.4
Liquid Recovery, vol%	107.9	106.4	108.1
Hydrocarbons in Overhead Gas, wt%	1.9	0.9	0.8
Total Prod. Recovery, wt%	102.0	100.0	101.4
Total Prod. Recovery, vol%	113.9	109.1	109.7

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-3 Page 1

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	Day 6	Day 8	Day 10 (Ref Run)
IBP	125	205	44	34	47
10%	295	289	159	168	162
20%	311	321	227	234	227
30%	331	344	254	273	270
40%	349	361	292	299	299
50%	368	378	313	320	325
60%	387	396	335	342	349
70%	408	417	359	367	372
80%	432	441	399	396	400
90%	454	473	433	440	443
FBP	555	572	556	562	549

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	Day 6	Day 8	Day 10 (Ref Run)
Monocaromatics	29.10	41.72	44.93	46.95	14.45
Diaromatics	13.50	5.50	1.54	3.67	0.31
PNA's	12.70	6.22	0.89	2.25	0.17
Total N	1934	853	3.9	11.7	1.5
Basic N	739	200	N.A.*	N.A.*	N.A.*
Total S	34200	1500	235.0	931.0	370.0
Densities @ 15C (g/cc)	.9564	.9344	.9772	.9850	.9690

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	Day 6	Day 8	Day 10 (Ref Run)
Light Ends (Gas)*	-	-	3.3	1.7	1.4
IBP-195C Naph	-	-	17.7	15.6	17.7
195-290C Lt. D	12.6	11.7	26.4	24.6	24.2
290-360C Hv D	35.3	29.5	32.8	32.4	30.1
360C+ Residue	51.6	59.1	30.9	33.7	36.3

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 266-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: M3-4
Date of Report: 1985-04-22

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-03-10
Feed: SYNCRUDE GAS OIL + SUNCOR EXTRACT Sample No.: MR-3-EXP-4
Reference Feed: RAW SYNCRUDE GAS OIL
Comments:

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.97
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	Day 9	Day 9	Day 10 (Ref Run)
Feed Volume, cc (ambient)	112.00	106.00	151.00
Feed Density at 15C	0.9365	0.9365	0.9344
Feed Density, g/cc (ambient)	0.9316	0.9316	0.9295
Total Liquid Product, g	102.25	98.08	138.21
TLP Density at 15C	0.8505	0.8520	0.8525
TLP Density, g/cc (ambient)	0.8461	0.8470	0.8481
Stabilizer Gas Volume, L	143.65	103.10	166.70
Temperature, C	23.5	27.5	27.5
Pressure, mm Hg	750	750	750

Stabilizer Gas Analyses, mole% on air- and water-free basis

	Day 9	Day 9	Day 10
Hydrogen	99.22	98.46	99.34
Methane	0.25	0.40	0.20
Ethane	0.09	0.14	0.07
Propane	0.21	0.33	0.19
Iso-Butane	0.08	0.14	0.08
n-Butane	0.00	0.00	0.00
Iso-Pentane	0.05	0.41	0.05
n-Pentane	0.00	0.00	0.00
Hexanes Plus	0.00	0.00	0.00
Hydrogen Sulfide	0.10	0.12	0.07
Ammonia	0.00	0.00	0.00

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FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	Day 6	Day 9	Day 10 (Ref Run)
IBP	148	205	27	21	24
10%	195	189	127	125	122
20%	317	321	193	190	188
30%	340	344	235	234	237
40%	357	362	272	270	277
50%	374	378	301	299	301
60%	392	396	329	327	329
70%	414	417	355	353	355
80%	438	441	383	381	385
90%	470	473	429	428	430
FBP	529	572	539	537	537

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	Day 6	Day 9	Day 10 (Ref Run)
Monoaromatics	40.59	41.72	12.77	13.93	11.91
Diaromatics	3.92	3.50	0.20	0.15	0.08
PNA-s	7.22	6.22	0.10	0.04	0.11
Total N	1145	263	0.5	0.5	0.1
Basic N	269	200	N.A.*	N.A.*	N.A.*
Total S	3700	1500	20.0	203.0	52.0
Densities @ 15C (g/cc)	.9365	.9344	.8505	.8520	.8525

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	Day 6	Day 10 (Ref Run)
IBP-195C Napn	-	-	0.7915	0.7915
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: M3-4
Date of Report: 1985-04-22

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-03-10
Feed: SYNCRUDE GAS OIL + SUNCOR EXTRACT Sample No.: MR-3-EXP-4
Reference Feed: FAW SYNCRUDE (GAS OIL)
Comments:

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 51.4
Catalyst Volume, cc 110.93
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	Day 5	Day 8	Day 10 (Ref Run)
Liquid Recovery, wt%	98.0	99.3	98.2
Liquid Recovery, vol%	107.9	109.2	107.9
Hydrocarbons in Overhead Gas, wt%	1.4	2.6	1.0
Total Prod. Recovery, wt%	99.5	102.1	99.7
Total Prod. Recovery, vol%	110.5	114.1	109.6

*Includes hydrogen sulfide and ammonia in the overhead gas

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FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	Day 6	Day 8	Day 10 (Ref Run)
IBP	148	205	23	21	24
10%	185	289	127	125	172
20%	317	321	192	190	194
30%	340	344	236	234	237
40%	357	363	272	270	277
50%	374	378	301	299	301
60%	391	396	329	327	329
70%	414	417	355	353	356
80%	438	441	385	383	385
90%	470	477	429	428	470
FBP	565	572	538	537	537

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	Day 6	Day 8	Day 10 (Ref Run)
Monoaromatics	40.58	41.73	12.77	13.93	11.91
Diaromatics	8.92	8.60	0.20	0.16	0.08
PNA-s	7.22	6.22	0.10	0.04	0.11
Total N	1145	963	0.5	0.5	0.1
Basic N	269	200	N.A.*	N.A.*	N.A.*
Total S	5700	1500	20.0	203.0	52.0
Densities @ 15C (g/cc)	.9365	.9344	.9505	.9520	.9525

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	Day 6	Day 8	Day 10 (Ref Run)
Light Ends (Gas)*	-	-	2.4	4.7	1.8
1BP-195C Naph	-	-	24.2	25.0	27.8
195-290C Lt D	12.5	11.7	27.6	28.3	28.0
290-360C Hv D	31.7	29.6	26.8	27.2	26.7
360C+ Residue	55.9	59.1	29.2	28.7	29.2

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: In-MR2-5
Date of Report: 1985-06-06

* INPUT DATA *

RUN DESCRIPTION

Date of Commencing the Run: 1985-04-11
Feed: RAW SYNCRUDE GAS OIL Sample No.: MR-2EXP-E
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	DAY 6	DAY 8	DAY 10 (Ref Run)
Feed Volume, cc (ambient)	133.50	85.00	129.00
Feed Density at 15C	0.9344	0.9344	0.9295
Feed Density, g/cc (ambient)	0.9285	0.9285	0.9236
Total Liquid Product, g	123.89	90.42	118.71
TLP Density at 15C	0.8505	0.8544	0.8277
TLP Density, g/cc (ambient)	0.8461	0.8500	0.8234
Stabilizer Gas Volume, L	136.06	96.70	127.33
Temperature, C	27.5	24.0	27.0
Pressure, mm Hg	750	747	754

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.29	99.54	99.41
Methane	0.20	0.16	0.15
Ethane	0.07	0.02	0.02
Propane	0.19	0.17	0.21
Iso-Butane	0.09	0.08	0.17
n-Butane	0.00	0.00	0.00
Iso-Pentane	0.06	0.00	0.03
n-Pentane	0.00	0.00	0.00
Hexanes Plus	0.00	0.00	0.00
Hydrogen Sulfide	0.10	0.03	0.03
Ammonia	0.00	0.00	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 6	DAY 8	DAY 10 (Ref Run)
IBP	205	236	37	52	2
10%	289	297	142	150	115
20%	321	326	203	209	162
30%	344	346	247	251	204
40%	362	363	281	283	244
50%	378	379	308	308	279
60%	396	398	334	332	307
70%	417	418	359	355	336
80%	441	442	386	382	366
90%	473	474	427	422	407
FBP	572	573	522	518	511

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 6	DAY 8	DAY 10 (Ref Run)
Monoaromatics	41.72	40.48	10.09	11.57	5.06
Diaromatics	9.60	7.50	0.14	0.05	0.00
PNA-s	6.22	5.06	0.05	0.13	0.00
Total N	963	246	1.9	1.0	1.0
Basic N	200	1	N.A.*	N.A.*	N.A.*
Total S	1500	1200	13.0	9.0	49.0
Densities @ 15C (g/cc)	.9344	.9295	.8505	.8544	.8277

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	DAY 6	DAY 10 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.9875	0.9875

* N.A.=Not Available - expected to be below the detection limit of 30

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: IN-mr2-5
Date of Report: 1985-06-0c

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-04-11
Feed: RAW SYNCRUDE GAS OIL Sample No.: MR-2EXP-5
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	DAY 5	9	10	Ref Run
Liquid Recovery, wt%	99.9	101.9	99.9	
Liquid Recovery, vol%	109.7	110.7	111.2	
Hydrocarbons in Overhd Gas, wt%	1.0	0.9	0.9	
Total Prod. Recovery, wt%	101.1	102.7	100.6	
Total Prod. Recovery, vol%	111.7	112.1	112.9	

*Includes hydrogen sulfide and ammonia in the overhead gas

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FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 6	8	10	Ref Run
IBP	205	236	37	52		2
10%	299	297	142	150		116
20%	321	326	203	209		162
30%	344	346	247	251		204
40%	362	363	281	287		244
50%	378	379	308	308		278
60%	396	398	334	332		307
70%	417	418	359	355		336
80%	441	442	386	382		366
90%	473	474	427	422		407
FBP	572	573	522	518		511

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 6	8	10	Ref Run
Monoaromatics	41.72	40.48	10.09	11.53		5.06
Diaromatics	9.60	7.50	0.14	0.05		0.00
PNA-s	6.22	5.06	0.05	0.13		0.00
Total N	963	246	1.8	1.0		1.0
Basic N	200	1	N.A.*	N.A.*		N.A.*
Total S	1500	1200	13.0	9.0		49.0
Densities @ 15C (g/cc)	.9344	.9295	.8505	.8500		.8234

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	DAY 6	8	10	Ref Run
Light Ends (Gas)*	-	-	1.8	1.4		1.7
IBP-195C Naph	-	-	22.1	21.1		33.8
195-290C Lt D	11.3	9.0	27.4	28.7		29.3
290-360C Hv D	29.6	30.8	29.0	32.0		26.0
360C* Residue	58.6	59.4	31.3	30.2		23.4

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

Output File No.: IN-CORE

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-94-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: IN-3-EXP-5-30
Date of Report: 1985-08-11

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-02
Feed: RAW SYNCRUDE GAS OIL Sample No.: MR-2-E
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

18 20 (Ref Run)

Feed Volume, cc (ambient)	101.50	112.00
Feed Density at 15C	0.9344	0.9295
Feed Density, g/cc (ambient)	0.9285	0.9236
Total Liquid Product, g	94.07	107.24
TLP Density at 15C	0.8589	0.8291
TLP Density, g/cc (ambient)	0.8543	0.8242
Stabilizer Gas Volume, L	86.00	116.40
Temperature, C	25.0	24.0
Pressure, mm Hg	750	753

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.48	99.27
Methane	0.13	0.15
Ethane	0.01	0.00
Propane	0.14	0.21
Iso-Butane	0.07	0.17
n-Butane	0.00	0.00
Iso-Pentane	0.00	0.00
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.05	0.07
Ammonia	0.00	0.00

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FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	18	20 (Ref Run)
IBP	205	236	75	7
10%	289	297	159	119
20%	321	326	227	157
30%	344	346	268	207
40%	362	363	296	247
50%	378	379	321	280
60%	396	398	344	308
70%	417	418	366	338
80%	441	442	392	369
90%	473	474	432	410
FBP	572	573	525	516

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	18	20 (Ref Run)
Monoaromatics	41.72	40.48	13.52	5.54
Diaromatics	8.60	7.50	0.31	0.04
PNA-s	6.22	5.06	0.10	0.03
Total N	963	246	1.0	1.5
Basic N	200	1	N.A.*	N.A.*
Total S	1500	1200	38.0	7.5
Densities @ 15C (g/cc)	.9344	.9295	.8588	.8285

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	18	20 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: IN-3-EXP-5-30
Date of Report: 1985-08-12

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-02
Feed: RAW SYNCRUDE GAS OIL Sample No.: MR-2-E
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	19	20 (Ref Run)
Liquid Recovery, wt%	99.8	99.8
Liquid Recovery, vol%	108.5	111.9
Hydrocarbons in Ovhd Gas, wt%	0.5	0.6
Total Prod. Recovery, wt%*	100.3	100.9
Total Prod. Recovery, vol%*	109.4	113.5

*Includes hydrogen sulfide and ammonia in the overhead gas

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FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	18	20 (Ref Run)
IBP	205	234	75	7
10%	299	297	169	119
20%	321	326	227	167
30%	344	346	268	207
40%	362	363	296	247
50%	378	379	321	280
60%	396	398	344	308
70%	417	418	366	338
80%	441	442	392	369
90%	473	474	432	410
FBP	572	573	525	516

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	18	20 (Ref Run)
Monoaromatics	41.72	40.48	13.52	5.54
Diaromatics	9.60	7.50	0.31	0.04
PNA-s	6.22	5.06	0.10	0.03
Total N	963	246	1.0	1.5
Basic N	200	1	N.A.*	N.A.*
Total S	1500	1200	18.0	7.5
Densities @ 15C (g/cc)	.9344	.9295	.8588	.8285

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	18	20 (Ref Run)
Light Ends (Gas)*	-	-	0.6	1.6
IBP-195C Naph	-	-	16.8	32.6
195-290C Lt D	11.3	9.0	26.0	29.6
290-360C Hv D	29.6	30.8	31.4	35.5
360C+ Residue	58.6	59.4	34.4	24.7

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

Output File No.: OUT-IN-C

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: IN-2-EXP-5-30
 Date of Report: 1985-07-02

*** INPUT DATA ***

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-02
 Feed: RAW SYNCRUDE GAS OIL Sample No.: MR-2-E
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.7
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	DAY 28	DAY 30 (Ref Run)
Feed Volume, cc (ambient)	130.00	129.00
Feed Density at 15C	0.9344	0.9295
Feed Density, g/cc (ambient)	0.9285	0.9236
Total Liquid Product, g	119.31	118.01
TLP Density at 15C	0.8580	0.8296
TLP Density, g/cc (ambient)	0.8534	0.8251
Stabilizer Gas Volume, L	137.50	131.70
Temperature, C	24.5	25.0
Pressure, mm Hg	749	741

Stabilizer Gas Analyses, mole% on air- and water-free basis

	DAY 28	DAY 30
Hydrogen	99.42	99.11
Methane	0.15	0.29
Ethane	0.00	0.06
Propane	0.15	0.25
Iso-Butane	0.08	0.14
n-Butane	0.00	0.00
Iso-Pentane	0.05	0.05
n-Pentane	0.00	0.00
Hexanes Plus	0.10	0.04
Hydrogen Sulfide	0.05	0.07
Ammonia	0.00	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 28	DAY 30 (Ref Run)
IBP	205	236	37	15
10%	289	297	147	118
20%	321	326	209	165
30%	344	346	252	207
40%	362	363	285	245
50%	378	379	310	279
60%	396	398	335	309
70%	417	418	360	338
80%	441	442	388	369
90%	473	474	430	413
FBP	572	573	532	537

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 28	DAY 30 (Ref Run)
Monoaromatics	41.72	40.48	13.55	4.21
Diaromatics	8.60	7.50	0.35	0.05
PNA-s	6.22	5.06	0.09	0.02
Total N	963	246	1.0	1.1
Basic N	200	1	N.A.*	N.A.*
Total S	1500	1200	16.0	110.6
Densities @ 15C (g/cc)	.9344	.9295	.8580	.8296

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	DAY 28	DAY 30 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A. Not Available - expected to be below the detection limit of 30

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task ~~364-04-64~~: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: IN-2-EXP-5-30
Date of Report: 1985-07-02

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-02
Feed: RAW SYNCRUDE GAS OIL Sample No.: MR-2-5
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	DAY 28	DAY 30 (Ref Run)
Liquid Recovery, wt%	98.8	99.0
Liquid Recovery, vol%	107.5	110.9
Hydrocarbons in Ovhd Gas, wt%	1.2	1.5
Total Prod. Recovery, wt%*	100.1	100.7
Total Prod. Recovery, vol%*	109.8	113.7

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-5 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 28	DAY 30 (Ref Run)
IBP	205	236	37	12
10%	289	297	147	118
20%	321	326	209	165
30%	344	346	252	207
40%	362	363	285	245
50%	378	379	310	279
60%	396	398	335	309
70%	417	418	360	338
80%	441	442	388	349
90%	473	474	430	413
FBP	572	573	532	537

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 28	DAY 30 (Ref Run)
Monoaromatics	41.72	40.48	13.55	4.81
Diaromatics	9.60	7.50	0.35	0.05
PNA-s	6.22	5.06	0.09	0.02
Total N	963	246	1.0	1.1
Basic N	200	1	N.A.*	N.A.*
Total S	1500	1200	16.0	110.6
Densities @ 15C (g/cc)	.9344	.9295	.8580	.8296

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	DAY 28	DAY 30 (Ref Run)
Light Ends (Gas)*	-	-	7.1	7.7
IBP-193C Naph	-	-	30.4	32.4
193-290C Lt D	11.3	9.0	26.7	29.3
290-360C Hv D	29.6	30.8	29.4	25.3
360C+ Residue	58.6	59.4	31.1	24.0

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-94-94: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: IN-3-6 -
 Date of Report: 1985-06-04

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-04-15
 Feed: RAW SUNCOR COKER GAS OIL Sample No.: MR-JEXP-6
 Reference Feed: DEN2 SUNCOR COKER GAS OIL
 Comments: REACTOR PLUGGING PROBLEMS

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.9
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	DAY 6	DAY 10 (Ref Run)
Feed Volume, cc (ambient)	96.00	132.50
Feed Density at 15C	0.9584	0.9490
Feed Density, g/cc (ambient)	0.9534	0.9444
Total Liquid Product, g	94.35	115.89
TLP Density at 15C	0.8740	0.8426
TLP Density, g/cc (ambient)	0.8786	0.8470
Stabilizer Gas Volume, L	118.80	155.30
Temperature, C	24.0	26.0
Pressure, mm Hg	756	754

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	97.87	98.00
Methane	0.46	0.45
Ethane	0.24	0.16
Propane	0.23	0.28
Iso-Butane	0.08	0.10
n-Butane	0.00	0.00
Iso-Pentane	0.05	0.02
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	1.07	0.99
Ammonia	0.00	0.00

EXP-6 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 6	DAY 10 (Ref Run)
IBP	125	124	29	25
10%	286	285	175	140
20%	311	310	236	198
30%	331	330	271	240
40%	349	350	295	272
50%	368	370	315	296
60%	387	385	335	317
70%	408	410	356	340
80%	432	430	382	367
90%	464	464	422	407
FBP	555	555	535	517

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 6	DAY 10 (Ref Run)
Monoaromatics	29.10	29.10	44.69	26.34
Diaromatics	13.50	13.50	0.93	0.49
PNA-s	12.70	12.70	1.10	0.26
Total N	662	1934	15.8	1.0
Basic N	252	739	N.A.*	N.A.*
Total S	33300	34200	989.0	110.0
Densities @ 15C (g/cc)	.9584	.9490	.8740	.8426

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	DAY 6	DAY 10 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-94-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: IN-3-6
Date of Report: 1995-06-04

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1995-04-15
Feed: RAW SUNCOR COKER GAS OIL Sample No.: MR-3EXP-6
Reference Feed: DEN2 SUNCOR COKER GAS OIL
Comments: REACTOR PLUGGING PROBLEMS

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.9
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	DAY 6	DAY 10 (Ref Run)
Liquid Recovery, wt%	103.1	92.6
Liquid Recovery, vol%	111.9	103.3
Hydrocarbons in Ovhd Gas, wt%	1.7	1.6
Total Prod. Recovery, wt%*	106.8	95.9
Total Prod. Recovery, vol%*	117.4	108.2

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-6 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 6	DAY 10 (Ref Run)
IBP	125	124	29	25
10%	296	295	175	140
20%	311	310	236	198
30%	331	330	271	240
40%	349	350	295	272
50%	368	370	315	296
60%	397	395	335	317
70%	408	410	356	340
80%	432	430	382	367
90%	464	464	422	407
FBP	555	555	535	517

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 6	DAY 10 (Ref Run)
Monoaromatics	29.10	29.10	44.69	26.34
Diaromatics	13.50	13.50	0.93	0.49
PNA-s	12.70	12.70	1.10	0.26
Total N	562	1934	15.9	1.0
Basic N	252	739	N.A.*	N.A.*
Total S	33300	34200	989.0	110.0
Densities @ 15C (g/cc)	.9584	.9490	.8740	.8426

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	DAY 6	DAY 10 (Ref Run)
Light Ends (Gas)*	-	-	3.2	2.9
IBP-195C Naph	-	-	15.6	22.0
195-290C Lt D	12.9	13.1	28.9	29.2
290-360C Hv D	36.6	34.6	37.6	30.7
360C+ Residue	53.2	54.3	31.0	22.4

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

Output File No.: OUT-3-e

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: IN-CARBAZOLE DEN2 GAS OIL
 Date of Report: 1985-07-03

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-05 **EXP-7**
 Feed: CARBAZOLE DEN2 GAS OIL Sample No.: MR-3-7-CA
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.87
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	DAY 6	DAY 8 (Ref Run)
Feed Volume, cc (ambient)	107.00	131.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	98.18	120.65
TLP Density at 15C	0.8206	0.8125
TLP Density, g/cc (ambient)	0.8163	0.8167
Stabilizer Gas Volume, L	116.70	151.40
Temperature, C	24.0	23.5
Pressure, mm Hg	750	753

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.44	99.09
Methane	0.13	0.13
Ethane	0.01	0.04
Propane	0.21	0.21
Iso-Butane	0.14	0.13
n-Butane	0.00	0.00
Iso-Pentane	0.00	0.03
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.32
Hydrogen Sulfide	0.07	0.05
Ammonia	0.00	0.00

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 6	DAY 8 (Ref Run)
IBP	236	236	24	22
10%	297	297	107	103
20%	326	326	151	142
30%	346	346	194	178
40%	363	363	229	209
50%	379	379	264	243
60%	398	398	294	276
70%	418	418	324	308
80%	442	442	355	343
90%	474	474	398	385
FBP	573	573	516	514

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 6	DAY 8 (Ref Run)
Monoaromatics	40.48	40.48	3.05	2.51
Diaromatics	7.50	7.50	0.00	0.00
PNA-s	5.06	5.06	0.00	0.00
Total N	449	246	1.5	1.3
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	27.4	16.9
Densities @ 15C (g/cc)	.9295	.9295	.8206	.8125

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	DAY 6	DAY 8 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 368-84-84: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: IN-CARBAZOLE DEN2 GAS OIL
Date of Report: 1985-07-03

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-05 **EXP-7**
Feed: CARBAZOLE DEN2 GAS OIL Sample No.: MR-3-7-CA
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	DAY 6	DAY 8 (Ref Run)
Liquid Recovery, wt%	99.3	99.7
Liquid Recovery, vol%	112.4	112.8
Hydrocarbons in Ovhd Gas, wt%	0.9	2.5
Total Prod. Recovery, wt%*	100.4	102.3
Total Prod. Recovery, vol%*	114.2	117.4

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 6	DAY 8 (Ref Run)
IBP	236	236	24	22
10%	297	297	107	103
20%	326	326	151	142
30%	346	346	194	178
40%	363	363	229	209
50%	379	379	264	243
60%	398	398	294	276
70%	418	418	324	308
80%	442	442	355	343
90%	474	474	398	385
FBP	573	573	516	514

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 6	DAY 8 (Ref Run)
Monoaromatics	40.48	40.48	3.05	2.51
Diaromatics	7.50	7.50	0.00	0.00
PNA-s	5.06	5.06	0.00	0.00
Total N	449	246	1.5	1.3
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	27.4	16.9
Densities @ 15C (g/cc)	.9295	.9295	.8206	.8125

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	DAY 6	DAY 8 (Ref Run)
Light Ends (Gas)*	-	-	1.7	4.5
IBP-195C Naph	-	-	36.6	43.2
195-290C Lt D	9.0	9.0	31.6	32.5
290-360C Hv D	30.8	30.8	24.5	21.6
360C+ Residue	59.0	59.4	19.8	16.8

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: OCTADECYLAMINE DOPED DEN2
 Date of Report: 1985-07-08

* INPUT DATA *

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-12
 Feed: OCTADECYLAMINE DEN2 GAS OIL Sample No.: MR-3-7-OCT
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.8
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	DAY 3	DAY 5 (Ref Run)
Feed Volume, cc (ambient)	129.00	131.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	117.98	119.99
TLP Density at 15C	0.8520	0.8320
TLP Density, g/cc (ambient)	0.8474	0.8275
Stabilizer Gas Volume, L	151.30	137.30
Temperature, C	24.5	25.0
Pressure, mm Hg	742	749

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.17	98.98
Methane	0.11	0.10
Ethane	0.04	0.08
Propane	0.15	0.21
Iso-Butane	0.10	0.14
n-Butane	0.00	0.00
Iso-Pentane	0.06	0.15
n-Pentane	0.00	0.01
Hexanes Plus	0.33	0.27
Hydrogen Sulfide	0.04	0.06
Ammonia	0.00	0.00

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FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 3	DAY 5 (Ref Run)
IBP	236	236	36	0
10%	297	297	120	118
20%	326	326	194	163
30%	346	346	249	205
40%	363	363	286	246
50%	379	379	314	290
60%	398	398	338	310
70%	418	418	359	340
80%	442	442	393	371
90%	474	474	432	420
FBP	573	573	527	518

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 3	DAY 5 (Ref Run)
Monoaromatics	40.48	40.48	11.23	4.59
Diaromatics	7.50	7.50	0.01	0.05
PNA-s	5.06	5.06	0.02	0.02
Total N	1027	246	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	7.3	38.6
Densities @ 15C (g/cc)	.9295	.9295	.8520	.8320

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	DAY 3	DAY 5 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: OCTADECYLAMINE DOPED DEN2
Date of Report: 1985-07-08

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-12
Feed: OCTADECYLAMINE DEN2 GAS OIL Sample No.: MR-3-7-OCT
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	DAY 3	DAY 5 (Ref Run)
Liquid Recovery, wt%	98.9	99.2
Liquid Recovery, vol%	107.8	110.7
Hydrocarbons in Dvhd Gas, wt%	2.4	2.6
Total Prod. Recovery, wt%*	101.5	101.8
Total Prod. Recovery, vol%*	112.3	115.4

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	DAY 3	DAY 5 (Ref Run)
IBP	236	236	36	0
10%	297	297	120	118
20%	326	326	194	163
30%	346	346	249	205
40%	363	363	286	246
50%	379	379	314	280
60%	398	398	338	310
70%	418	418	359	340
80%	442	442	393	371
90%	474	474	432	420
FBP	573	573	527	518

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DAY 3	DAY 5 (Ref Run)
Monoaromatics	40.48	40.48	11.23	4.59
Diaromatics	7.50	7.50	0.01	0.05
PNA-s	5.06	5.06	0.02	0.02
Total N	1027	246	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	7.3	38.6
Densities @ 15C (g/cc)	.9295	.9295	.8520	.8320

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	DAY 3	DAY 5 (Ref Run)
Light Ends (Gas)*	-	-	4.4	4.6
IBP-195C Naph	-	-	23.8	33.1
195-290C H ₂ O	9.0	9.0	23.0	28.3
290-360C Hv D	30.8	30.8	30.5	24.9
360C+ Residue	59.0	59.4	30.7	24.6

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

Output File No.: OUT-C18AMINE

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: ACRIDINE DOPED FEED
 Date of Report: 1985-08-02

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-07-10
 Feed: ACRIDINE DOPED FEED Sample No.: MR-3-7-ACF
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.8
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

1 5
 (Ref Run)

Feed Volume, cc (ambient)	129.50	125.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	119.00	114.90
TLP Density at 15C	0.8620	0.8318
TLP Density, g/cc (ambient)	0.8573	0.8273
Stabilizer Gas Volume, L	119.00	131.40
Temperature, C	24.0	24.0
Pressure, mm Hg	741	740

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	98.39	98.98
Methane	0.29	0.10
Ethane	0.00	0.08
Propane	0.22	0.21
Iso-Butane	0.10	0.14
n-Butane	0.00	0.00
Iso-Pentane	0.06	0.15
n-Pentane	0.00	0.01
Hexanes Plus	0.00	0.27
Hydrogen Sulfide	0.06	0.06
Ammonia	0.00	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	47	11
10%	297	297	169	110
20%	326	326	234	157
30%	346	346	275	199
40%	363	363	304	237
50%	379	379	330	273
60%	398	398	353	303
70%	418	418	376	334
80%	442	442	406	366
90%	474	474	446	411
FBP	573	573	560	540

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monoaromatics	40.48	40.48	11.17	5.25
Diaromatics	7.50	7.50	0.19	0.04
PNA-s	5.06	5.06	0.04	0.00
Total N	922	246	1.9	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	84.5	19.2
Densities @ 15C (g/cc)	.9295	.9295	.8620	.8318

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	3	5 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: ACRIDINE DOPED FEED
Date of Report: 1985-08-02

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-07-10
Feed: ACRIDINE DOPED FEED Sample No.: MR-3-7-ACR
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	3	5 (Ref Run)
Liquid Recovery, wt%	99.5	99.5
Liquid Recovery, vol%	107.2	111.1
Hydrocarbons in Ovhd Gas, wt%	1.0	2.6
Total Prod. Recovery, wt%*	100.5	102.2
Total Prod. Recovery, vol%*	109.0	115.9

*Includes hydrogen sulfide and ammonia in the overhead gas

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	47	11
10%	297	297	159	110
20%	326	326	234	157
30%	346	346	275	199
40%	363	363	304	237
50%	379	379	330	273
60%	398	398	357	303
70%	418	418	376	334
80%	442	442	406	366
90%	474	474	446	411
FBP	573	573	560	540

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monoaromatics	40.48	40.48	11.13	5.25
Diaromatics	7.50	7.50	0.19	0.04
PNA-s	5.06	5.06	0.04	0.00
Total N	922	246	1.9	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	84.5	19.2
Densities @ 15C (g/cc)	.9295	.9295	.8620	.8318

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	3	5 (Ref Run)
Light Ends (Gas)*	-	-	1.7	4.6
IBP-195C Naph	-	-	15.8	34.8
195-290C Lt D	9.0	9.0	23.5	29.4
290-360C Hv D	30.8	30.8	29.6	24.1
360C+ Residue	59.0	59.4	38.4	23.0

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: N-ETHYL CARBAZOLE DOPED DEN2
 Date of Report: 1985-08-01

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-08-18
 Feed: N-ETHYL CARBAZOLE DOPED FEED Sample No.: MR-3-7-NE
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.8
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

3 5 (Ref Run)

Feed Volume, cc (ambient)	128.00	141.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	117.64	129.38
TLP Density at 15C	0.8620	0.8387
TLP Density, g/cc (ambient)	0.8573	0.8342
Stabilizer Gas Volume, L	124.40	134.80
Temperature, C	24.0	24.0
Pressure, mm Hg	753	753

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.46	99.42
Methane	0.13	0.14
Ethane	0.00	0.00
Propane	0.16	0.19
Iso-Butane	0.07	0.13
n-Butane	0.00	0.00
Iso-Pentane	0.00	0.00
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.08	0.09
Ammonia	0.00	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	44	23
10%	297	297	154	122
20%	326	326	222	176
30%	346	346	256	220
40%	363	363	296	261
50%	379	379	323	293
60%	398	398	346	322
70%	418	418	369	348
80%	442	442	399	379
90%	474	474	437	421
FBP	573	573	532	524

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monoaromatics	40.48	40.48	11.99	5.53
Diaromatics	7.50	7.50	0.19	0.06
PNA-s	5.06	5.06	0.05	0.03
Total N	894	246	1.0	1.0
Basic N		1	N.A.*	N.A.*
Total S	1200	1200	5.7	5.8
Densities @ 15C (g/cc)	.9295	.9295	.8620	.8387

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	3	5 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9579	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 10 ppm

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: N-ETHYL CARBAZOLE DOPED DEN2
Date of Report: 1985-08-01

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-08-18
Feed: N-ETHYL CARBAZOLE DOPED FEED Sample No.: MR-3-7-NET
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	3	5 (Ref Run)
Liquid Recovery, wt%	99.5	99.7
Liquid Recovery, vol%	107.2	110.0
Hydrocarbons in Ovhd Gas, wt%	0.6	0.8
Total Prod. Recovery, wt%*	100.2	100.2
Total Prod. Recovery, vol%*	108.3	111.5

*Includes hydrogen sulfide and ammonia in the overhead gas

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	44	27
10%	297	297	154	122
20%	326	326	222	176
30%	346	346	266	220
40%	363	363	296	261
50%	379	379	323	293
60%	398	398	346	322
70%	419	419	369	348
80%	442	442	399	379
90%	474	474	437	421
FBP	573	573	532	524

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monoaromatics	40.48	40.48	11.99	5.53
Diaromatics	7.50	7.50	0.19	0.06
PNA-s	5.06	5.06	0.05	0.03
Total N	894	246	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	5.7	5.8
Densities @ 15C (g/cc)	.9295	.9295	.8620	.8387

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	3	5 (Ref Run)
Light Ends (Gas)*	-	-	1.0	1.4
IBP-195C Naph	-	-	18.3	28.9
195-290C Lt D	9.0	9.0	24.3	27.3
290-360C Hv D	30.8	30.8	29.7	26.7
360C+ Residue	59.0	59.4	35.0	27.2

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: N-PNA DOPED FEED
 Date of Report: 1985-08-01

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-08-20
 Feed: N-PHENYL NAPHTHYLAMINE DOPED FEED Sample No.: MR-3-7-N-PNA
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.87
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

3 5
 (Ref Run)

Feed Volume, cc (ambient)	130.00	128.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	119.57	117.42
TLP Density at 15C	0.8615	0.8381
TLP Density, g/cc (ambient)	0.8568	0.8336
Stabilizer Gas Volume, L	120.90	126.70
Temperature, C	24.0	27.0
Pressure, mm Hg	748	746

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.50	99.34
Methane	0.16	0.16
Ethane	0.00	0.00
Propane	0.15	0.21
Iso-Butane	0.08	0.13
n-Butane	0.00	0.00
Iso-Pentane	0.00	0.04
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.07	0.08
Ammonia	0.00	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	37	24
10%	297	297	149	123
20%	326	326	217	177
30%	346	346	267	220
40%	363	363	297	260
50%	379	379	323	291
60%	398	398	346	320
70%	418	418	369	347
80%	442	442	397	376
90%	474	474	437	419
FBP	573	573	531	522

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monocaromatics	40.48	40.48	13.73	6.28
Diaromatics	7.50	7.50	0.09	0.00
PNA-s	5.06	5.06	0.10	0.00
Total N	830	246	1.0	1.0
Basic N		1	N.A.*	N.A.*
Total S	1200	1200	6.3	7.8
Densities @ 15C (g/cc)	.9295	.9295	.8615	.8381

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	3	5 (Ref Run)
IBP-195C Naph	-	-	0.7915	0.7915
195-290C Lt D	0.9500	0.9500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.9875	0.8875

* N.A.=Not-Available - expected to be below the detection limit of 30 ppm

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: N-PNA DOPED FEED
 Date of Report: 1985-08-01

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-08-20
 Feed: N-PHENYL NAPHTHYLAMINE DOPED FEED Sample No.: MR-3-7-N-PNA
 Reference Feed: DENE SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.87
 Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	3	5 (Ref Run)
Liquid Recovery, wt%	99.6	99.3
Liquid Recovery, vol%	107.3	110.0
Hydrocarbons in Ovhd Gas, wt%	0.6	1.0
Total Prod. Recovery, wt%*	100.2	100.4
Total Prod. Recovery, vol%*	108.5	111.9

*Includes hydrogen sulfide and ammonia in the overhead gas

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	37	24
10%	297	297	148	123
20%	326	326	217	177
30%	346	346	267	220
40%	363	363	297	260
50%	379	379	323	291
60%	398	398	346	320
70%	418	418	369	347
80%	442	442	397	376
90%	474	474	437	419
FBP	573	573	531	522

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monoaromatics	40.48	40.48	13.73	6.28
Diaromatics	7.50	7.50	0.09	0.00
PNA-s	5.06	5.06	0.10	0.00
Total N	630	245	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	6.3	7.8
Densities @ 15C (g/cc)	.9295	.9295	.8615	.8381

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	3	5 (Ref Run)
Light Ends (Gas)*	-	-	1.0	1.7
IBP-195C Naph	-	-	19.6	29.8
195-290C Lt D	9.0	9.0	22.6	29.2
290-360C Hv D	30.8	30.8	30.1	26.6
360C+ Residue	59.0	59.4	35.1	26.6

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: D4PM DOPED FEED
 Date of Report: 1985-08-01

INPUT DATA

RUN DESCRIPTION

EXP-7

Date of Commencing the Run: 1985-06-15
 Feed: DIPHENYL-4-PYRIDYL METHANE DOPED FEED Sample No.: MR-3-7-D4PM
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.87
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

5 5
 (Ref Run)

Feed Volume, cc (ambient)	127.00	127.50
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	116.58	117.24
TLP Density at 15C	0.8620	0.8359
TLP Density, g/cc (ambient)	0.8573	0.8314
Stabilizer Gas Volume, L	128.90	139.20
Temperature, C	24.0	24.0
Pressure, mm Hg	745	750

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.43	99.41
Methane	0.16	0.12
Ethane	0.00	0.00
Propane	0.18	0.19
Iso-Butane	0.11	0.13
n-Butane	0.00	0.00
Iso-Pentane	0.00	0.00
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.08	0.07
Ammonia	0.00	0.00

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	46	23
10%	297	297	155	122
20%	326	326	226	173
30%	346	346	272	215
40%	363	363	301	257
50%	379	379	327	289
60%	398	398	349	317
70%	418	418	372	344
80%	442	442	401	374
90%	474	474	440	415
FBP	573	573	545	519

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monoaromatics	40.48	40.48	13.20	5.64
Diaromatics	7.50	7.50	0.24	0.04
PNA-s	5.06	5.06	0.04	0.00
Total N	827	246	1.0	1.0
Basic N		1	N.A.*	N.A.*
Total S	1200	1200	94.7	17.0
Densities @ 15C (g/cc)	.9295	.9295	.8620	.8359

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	3	5 (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8975

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: D4PM DOPED FEED
Date of Report: 1985-08-01

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-15
Feed: DIPHENYL-4-PYRIDYL METHANE DOPED FEED Sample No.: MR-3-7-D4PM
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	3	5 (Ref Run)
Liquid Recovery, wt%	99.4	99.6
Liquid Recovery, vol%	107.1	110.6
Hydrocarbons in Ovhd Gas, wt%	0.7	0.9
Total Prod. Recovery, wt%*	100.3	100.5
Total Prod. Recovery, vol%*	108.5	112.3

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5	(Ref Run)
IBP					
10%	236	236			
20%	297	297	46		23
30%	326	326	155		122
40%	346	346	226		173
50%	363	363	272		216
60%	379	379	301		257
70%	398	398	327		289
80%	418	418	349		317
90%	442	442	372		344
FBP	474	474	401		374
	573	573	440		415
			545		519

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5	(Ref Run)
Monoaromatics	40.48	40.48			
Diaromatics	7.50	7.50	13.20		5.64
PNA-s	5.06	5.06	0.24		0.04
Total N	827	246	0.04		0.00
Basic N		1	1.0		1.0
Total S	1200	1200	N.A.*		N.A.*
Densities @ 15C	.9295	.9295	94.7		17.0
(g/cc)			.8620		.8359

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	3	5	(Ref Run)
Light Ends (Gas)*	-	-			
IBP-195C Naph	-	-	1.3		1.5
195-290C Lt D	9.0	9.0	17.9		30.1
290-360C Hv D	30.8	30.8	22.6		27.9
360C+ Residue	59.0	59.4	30.3		26.9
			36.4		25.8

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: AMINDANTHRACENE
 Date of Report: 1985-08-14

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-07-15
 Feed: AMINDANTHRACENE DOPED FEED Sample No.: MR-3-EXP-7
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.7
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

3 5

(Ref Run)

Feed Volume, cc (ambient)	130.00	130.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	120.77	120.03
TLP Density at 15C	0.8342	0.8220
TLP Density, g/cc (ambient)	0.8299	0.8177
Stabilizer Gas Volume, L	146.00	142.00
Temperature, C	24.7	24.0
Pressure, mm Hg	756	754

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.35	99.25
Methane	0.17	0.18
Ethane	0.00	0.02
Propane	0.21	0.21
Iso-Butane	0.13	0.15
n-Butane	0.00	0.00
Iso-Pentane	0.00	0.03
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.08	0.07
Ammonia	0.00	0.00

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5
				(Ref Run)

IBP	236	236	11	22
10%	297	297	117	117
20%	326	326	170	167
30%	346	346	215	212
40%	363	363	257	253
50%	379	379	289	286
60%	398	398	317	315
70%	418	418	344	343
80%	442	442	373	373
90%	474	474	414	415
FBP	573	573	522	520

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5
				(Ref Run)

Monoaromatics	40.48	40.48	5.08	3.60
Diaromatics	7.50	7.50	0.03	0.02
PNA-s	5.06	5.06	0.00	0.00
Total N	255	246	0.5	0.4
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	73.0	47.0
Densities @ 15C	.9295	.9295	.8342	.8220
(g/cc)				

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	3	5
				(Ref Run)

IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.9875	0.9875

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

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EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	11	22
10%	297	297	117	117
20%	326	326	170	167
30%	346	346	215	212
40%	363	363	257	253
50%	379	379	289	286
60%	398	398	317	315
70%	418	418	344	343
80%	442	442	373	373
90%	474	474	414	415
FBP	573	573	522	520

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monoaromatics	40.48	40.48	5.09	3.60
Diaromatics	7.50	7.50	0.03	0.02
PNA-s	5.06	5.06	0.00	0.00
Total N	255	246	0.5	0.4
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	73.0	47.0
Densities @ 15C (g/cc)	.9295	.9295	.8342	.8220

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	3	5 (Ref Run)
Light Ends (Gas)	-	-	1.7	2.2
IBP-195C Naph	-	-	31.0	32.0
195-290C Lt D	9.0	9.0	27.8	28.4
290-360C Hv D	30.8	30.8	27.4	26.7
360C+ Residue	59.0	59.4	25.9	26.0

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

Output File No.: OUT-ANTH

EILF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-94-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: DIPHENYL-2-PYRIDYLMETHANE
 Date of Report: 1985-08-14

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-07-30
 Feed: DIPHENYL-2-PYRIDYLMETHANE DOPED FEED Sample No.: MR-3-EXP-7
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

IN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.7
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

3 5
 (Ref Run)

Feed Volume, cc (ambient)	130.00	130.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	124.44	119.61
TLP Density at 15C	0.8490	0.8324
TLP Density, g/cc (ambient)	0.8476	0.8311
Stabilizer Gas Volume, L	131.00	141.00
Temperature, C	26.5	25.0
Pressure, mm Hg	750	755

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	98.68	99.10
Methane	0.19	0.14
Ethane	0.00	0.00
Propane	0.13	0.15
Iso-Butane	0.00	0.04
n-Butane	0.00	0.00
Iso-Pentane	0.03	0.01
n-Pentane	0.00	0.00
Hexanes Plus	0.08	0.00
Hydrogen Sulfide	0.06	0.07
Ammonia	0.00	0.00

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EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	3	5 (Ref Run)
IBP	236	236	1	59
10%	297	297	118	178
20%	326	326	167	204
30%	346	346	209	250
40%	363	363	249	287
50%	379	379	281	310
60%	398	398	309	335
70%	419	419	337	359
80%	442	442	367	385
90%	474	474	408	426
FBP	573	573	522	537

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	3	5 (Ref Run)
Monoaromatics	40.48	40.48	9.31	4.70
Diaromatics	7.50	7.50	0.20	0.00
PNA-s	5.06	5.06	0.10	0.00
Total N	943	246	1.0	1.9
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	185.0	19.5
Densities @ 15C (g/cc)	.9295	.9295	.8490	.8324

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	3	5 (Ref Run)
IBP-195C Naph	-	-	0.7915	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

N.A.=Not Available - expected to be below the detection limit of 30 ppm

ALF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Report File No.: DIPHENYL-2-PYRIDYLMETHANE
Date of Report: 1985-08-14

HYDROCRACKING REPORT

DESCRIPTION

Date of Commencing the Run: 1985-07-30
Feed: DIPHENYL-2-PYRIDYLMETHANE DOPED FEED Sample No.: MR-3-EXP-7
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

OPERATING CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	3	5 (Ref Run)
Liquid Recovery, wt%	103.6	99.6
Liquid Recovery, vol%	112.9	110.7
Hydrocarbons in Dvhd Gas, wt%	0.8	0.6
Total Prod. Recovery, wt%	104.5	100.3
Total Prod. Recovery, vol%	114.4	111.8

Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	C	E (Ref Run)
IBP	236	236	1	59
10%	297	297	118	138
20%	326	326	167	204
30%	346	346	209	250
40%	363	363	249	283
50%	379	379	281	310
60%	398	398	309	335
70%	418	418	337	359
80%	442	442	367	385
90%	474	474	408	426
FBP	573	573	522	537

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	C	E (Ref Run)
Monoaromatics	40.48	40.48	9.31	4.70
Diaromatics	7.50	7.50	0.20	0.00
PNA-s	5.06	5.06	0.10	0.00
Total N	943	246	1.0	1.9
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	185.0	19.5
Densities @ 15C (g/cc)	.9295	.9295	.8490	.8324

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	C	E (Ref Run)
Light Ends (Gas)*	-	-	1.4	1.0
IBP-195C Naph	-	-	32.7	22.4
195-290C Lt D	9.0	9.0	30.0	26.9
290-360C Hv D	30.8	30.8	26.9	30.2
360C+ Residue	59.0	59.4	24.0	31.7

Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: PHENANTHRIDINE
 Date of Report:

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run:
 Feed: PHENANTHRIDINE SPIKED GAS OIL Sample No.: MR3-7
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.7
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	2	3	(Ref Run)
Feed Volume, cc (ambient)	129.00	129.00	
Feed Density at 15C	0.9295	0.9295	
Feed Density, g/cc (ambient)	0.9236	0.9236	
Total Liquid Product, g	124.38	121.32	
TLP Density at 15C	0.8571	0.8402	
TLP Density, g/cc (ambient)	0.7200	0.7061	
Stabilizer Gas Volume, L	138.00	129.00	
Temperature, C	24.0	25.0	
Pressure, mm Hg	756	748	

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.07	98.93
Methane	0.19	0.18
Ethane	0.00	0.07
Propane	0.16	0.22
Isobutane	0.00	0.17
n-Butane	0.00	0.00
Isopentane	0.12	0.00
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.05	0.07
Ammonia	0.00	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	T	E (Ref Run)
IBP	336	336	30	27
10%	297	297	142	135
20%	326	326	215	195
30%	346	346	262	209
40%	367	367	294	268
50%	379	379	320	297
60%	398	398	343	324
70%	419	419	366	350
80%	442	442	392	375
90%	474	474	432	419
FBP	577	577	532	527

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	T	E (Ref Run)
Monoaromatics	40.48	40.48	11.68	5.74
Diaromatics	7.50	7.50	0.07	0.03
PNA-s	5.06	5.06	0.12	0.07
Total N	550	546	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	163.0	51.0
Densities @ 15C (g/cc)	.9295	.9295	.8571	.8405

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	T	E (Ref Run)
IBP-195C Naph	-	-	0.7915	0.7915
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A. = Not Available - expected to be below the detection limit of 70

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: PHENANTHRIDINE
Date of Report:

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run:
Feed: PHENANTHRIDINE SPIKED GAS OIL Sample No.: MRC-
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	2	5	(Ref Run)
Liquid Recovery, wt%	104.4	101.6	
Liquid Recovery, vol%	133.9	133.2	
Hydrocarbons in Ovhd Gas, wt%	1.1	1.7	
Total Prod. Recovery, wt%	105.5	103.2	
Total Prod. Recovery, vol%	136.0	135.8	

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 1

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, D

	Feed	Ref Feed	T	E	Ref Run)
IBP	236	236	30	37	
10%	297	297	142	125	
20%	326	326	215	195	
30%	346	346	252	229	
40%	367	367	294	268	
50%	379	379	320	297	
60%	398	398	347	324	
70%	419	419	366	350	
80%	442	442	392	378	
90%	474	474	432	419	
FBP	572	572	532	527	

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	T	E	Ref Run)
Monocaromatics	40.48	40.48	11.68	5.74	
Diaromatics	7.50	7.50	0.07	0.03	
PNA-s	5.06	5.06	0.12	0.07	
Total N	950	246	1.0	1.0	
Basic N	1	1	N.A.*	N.A.*	
Total S	1200	1200	163.0	51.0	
Densities @ 15C	.9295	.9295	.9571	.8405	
(g/cc)					

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	T	E	Ref Run)
Light Ends (Gas)*	-	-	2.0	2.2	
IBP-195C Naph	-	-	20.9	27.1	
195-290C Lt D	9.0	9.0	25.0	28.6	
290-360C Hv D	30.9	30.8	31.9	28.6	
360C+ Residue	59.0	59.4	35.6	28.7	

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: PH INDOLE
Date of Report: 12-09-1985

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 12-08-1985 **EXP-7**
Feed: PHENYL INDOLE SPIKED GAS OIL Sample No.: MR-3-P1
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

2 3 (Ref Run)

Feed Volume, cc (ambient)	127.50	130.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	117.10	118.25
TLP Density at 15C	0.8600	0.8447
TLP Density, g/cc (ambient)	0.8555	0.7092
Stabilizer Gas Volume, L	121.50	131.00
Temperature, C	25.0	24.0
Pressure, mm Hg	751	750

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	89.07	89.41
Methane	0.14	0.17
Ethane	0.00	0.04
Propane	0.15	0.13
Iso-Butane	0.16	0.11
n-Butane	0.00	0.00
Iso-Pentane	0.07	0.07
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.06	0.07
Ammonia	0.00	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	C	E	(Ref Run)
IBP	234	234	32	32	
10%	297	297	147	129	
20%	326	326	220	190	
30%	346	346	268	255	
40%	363	363	297	275	
50%	379	379	324	303	
60%	398	398	347	330	
70%	419	419	370	354	
80%	442	442	398	380	
90%	474	474	439	420	
FBP	577	577	528	531	

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	C	E	(Ref Run)
Monoaromatics	40.48	40.48	10.78	8.42	
Diaromatics	7.50	7.50	0.01	0.13	
PNA-s	5.06	5.06	0.11	0.02	
Total N	531	546	1.0	1.0	
Basic N	1	1	N.A.*	N.A.*	
Total S	1200	1200	15.2	45.5	
Densities @ 15C (g/cc)	.9295	.9295	.8600	.8447	

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	C	E	(Ref Run)
IBP-195C Napn	-	-	0.7915	0.7915	
195-290C Lt D	0.8500	0.8500	0.8485	0.8485	
290-360C Hv D	0.9000	0.9000	0.8795	0.8795	
360C+ Residue	0.9753	0.9679	0.8975	0.8975	

* N.A. - Not Available - expected to be below the detection limit of GC

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: PH INDOLE
Date of Report: 12-09-1985

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 12-08-1985 **EXP-7**
Feed: PHENYL INDOLE SPIKED GAS OIL Sample No.: MR-3-PL
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	1	5 (Ref Run)
Liquid Recovery, wt%	99.4	98.5
Liquid Recovery, vol%	107.4	129.3
Hydrocarbons in Ovhd Gas, wt%	0.8	0.9
Total Prod. Recovery, wt%	100.4	99.5
Total Prod. Recovery, vol%	109.0	130.0

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 1

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	T	E (Ref Run)
IBP	236	236	32	21
10%	297	297	147	129
20%	326	326	220	190
30%	346	346	268	236
40%	367	367	297	273
50%	379	379	324	303
60%	398	398	347	330
70%	419	418	370	354
80%	442	442	398	380
90%	474	474	438	420
FBP	573	577	528	531

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	T	E (Ref Run)
Monoaromatics	40.48	40.48	10.78	8.42
Diaromatics	7.50	7.50	0.01	0.13
PNA-s	5.06	5.06	0.11	0.02
Total N	531	245	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	15.2	45.5
Densities @ 15C g/cc)	.9295	.9295	.8600	.8447

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	T	E (Ref Run)
Light Ends (Gas)*	-	-	1.5	1.5
IBP-195C Naph	-	-	19.2	14.9
195-290C Lt D	9.0	9.0	23.1	26.7
290-360C Hv D	30.8	30.8	29.7	38.6
360C+ Residue	59.0	59.4	35.6	38.2

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not incl

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: CARBAZOLE-2
Date of Report:

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 1985-19007 **EXP-7**
Feed: CARBAZOLE SPIKED GAS OIL Sample No.: MR-3-C
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

1 5 (Ref Run)

Feed Volume, cc (ambient)	129.00	130.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	119.73	119.48
TLP Density at 15C	0.8455	0.8410
TLP Density, g/cc (ambient)	0.8411	0.8366
Stabilizer Gas Volume, L	128.60	114.00
Temperature, C	23.0	23.0
Pressure, mm Hg	755	740

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	99.32	99.45
Methane	0.33	0.17
Ethane	0.00	0.00
Propane	0.31	0.19
Isobutane	0.16	0.15
n-Butane	0.00	0.00
Isopentane	0.00	0.00
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.07	0.07
Ammonia	0.00	0.00

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EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	T	S (Ref Run)
IBP	336	334	38	34
10%	397	397	124	128
20%	326	326	188	194
30%	346	346	236	227
40%	367	367	274	266
50%	379	379	302	296
60%	395	395	330	321
70%	413	413	355	349
80%	442	442	387	378
90%	474	474	425	420
END	577	577	522	520

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	T	S (Ref Run)
Monoaromatics	40.48	40.48	8.13	7.01
Diaromatics	7.30	7.30	0.00	0.00
PNA-s	5.04	5.04	0.07	0.04
Total N	427	346	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	2.0	5.0
Densities @ 150 (g/cc)	.9295	.9295	.9455	.8410

Fraction Densities at 150, g/cc

	Feed	Ref Feed	T	S (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.8500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.8679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: CARBAZOLE-2
Date of Report:

HYDROCRACKING REPORT

RUN DESCRIPTION

EXP-7

Date of Commencing the Run: 1985-19007
Feed: CARBAZOLE SPIKED GAS OIL Sample No.: MF-3-C
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 280 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.97
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	T	R	(Ref. Run)
Liquid Recovery, wt%	99.7	99.9	
Liquid Recovery, vol%	109.4	109.9	
Hydrocarbons in Ovhd Gas, wt%	1.2	0.7	
Total Prod. Recovery, wt%	101.0	100.7	
Total Prod. Recovery, vol%	111.6	111.7	

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 1

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, %

	Feed	Ref Feed	T	Ref Run
IBP	114	114	114	114
10%	114	114	114	114
20%	114	114	114	114
30%	114	114	114	114
40%	114	114	114	114
50%	114	114	114	114
60%	114	114	114	114
70%	114	114	114	114
80%	114	114	114	114
90%	114	114	114	114
BBP	114	114	114	114

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	T	Ref Run
Monoaromatics	40.48	40.48	8.17	7.01
Diaromatics	1.50	1.50	0.00	0.00
PNA's	5.06	5.06	0.07	0.04
Total N	47.7	47.7	1.0	1.0
Residue N	1	1	N.A.*	N.A.*
Total S	1200	1200	1.0	1.0
Residue S, 100 g (100)	.0297	.0297	.0497	.0410

INDIVIDUAL PRODUCT YIELDS, 111, 101% on the feed at 150

	Feed	Ref Feed	T	Ref Run
Light Ends (Gas)*	-	-	11.0	11.0
IBP-195C Naph	-	-	11.0	11.0
195-240C Lt D	8.0	8.0	11.0	11.0
240-360C Hv D	10.8	10.8	11.0	11.0
360C+ Residue	89.0	89.0	11.0	11.0

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included.

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 756-84-54: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: PHHENE IN
 Date of Report: 02-10-1988

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 12-09-1988 **EXP7**
 Feed: PHENETHRIDINE DOPED DEND Sample No.: MR-3-84
 Reference Feed: DEND
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 750 (1374)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.87
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

PHENETHRIDINE DEND REF
 (Ref Run)

Feed Volume, cc (ambient)	135.00	122.00
Feed Density at 15C	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	142.71	113.11
TLF Density at 15C	0.8717	0.8810
TLF Density, g/cc (ambient)	0.8667	0.8465
Stabilizer Gas Volume, L	157.00	155.50
Temperature, C	22.0	24.0
Pressure, mm Hg	755	751

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	59.12	59.35
Methane	0.15	0.12
Ethane	0.01	0.04
Propane	0.11	0.19
Isobutane	0.05	0.11
n-Butane	0.00	0.00
Isopentane	0.00	0.04
n-Pentane	0.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.07	0.11
Ammonia	0.00	0.00

EXP-7

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Analysis

	Feed	Ref Feed	PHENETHRIDINE	GENE REF
			(Ref Run)	
IBP	113	113	113	113
10%	114	114	114	114
20%	115	115	115	115
30%	116	116	116	116
40%	117	117	117	117
50%	118	118	118	118
60%	119	119	119	119
70%	120	120	120	120
80%	121	121	121	121
90%	122	122	122	122
BBP	123	123	123	123

Soluble Aromatics from 1% Distillation

	Feed	Ref Feed	PHENETHRIDINE	GENE REF
			(Ref Run)	
Monaromatics	40.45	40.45	15.17	5.07
Diaromatics	7.50	7.50	0.31	0.00
PNA's	5.06	5.06	0.20	0.07
Total N	550	550	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	157.0	51.0
Densities @ 150 (g/cc)	.8205	.8205	.8717	.8510

Fraction Densities at 150

	Feed	Ref Feed	PHENETHRIDINE	GENE REF
			(Ref Run)	
IBP-1950 Napr	-	-	0.7915	0.7915
195-2400 Lt D	0.8500	0.8500	0.8485	0.8485
240-3600 Hv D	0.8000	0.8000	0.8795	0.8795
3600+ Residue	0.8750	0.8750	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of GC run

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 186-94-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: PHHENE IN
Date of Report: 02-10-1985

HYDROCRACKING REPORT

RUN DESCRIPTION

EXP-7

Date of Commencing the Run: 12-09-1985
Feed: PHENETHRIDINE DOPED DENE Sample No.: MR-3-PH
Reference Feed: DENE
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 10.7 (1552.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.37
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

PHENETHRIDINE DENE REF
(Ref Run)

Liquid Recovery, wt%	99.7	100.5
Liquid Recovery, vol%	106.2	109.6
Hydrocarbons in Gvhd Gas, wt%	0.5	0.6
Total Prod. Recovery, wt%*	100.3	101.6
Total Prod. Recovery, vol%*	107.2	111.2

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, 1

	Feed	Ref Feed	PHENETHRIDINE (Ref Run)	DEN2 REF
IBP	236	236	68	74
10%	297	297	180	147
20%	326	326	286	212
30%	346	346	294	259
40%	367	367	320	291
50%	379	379	342	317
60%	398	398	362	340
70%	419	419	382	363
80%	442	442	406	391
90%	474	474	446	431
BBP	573	573	552	552

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	PHENETHRIDINE (Ref Run)	DEN2 REF
Monocaromatics	40.48	40.48	18.27	8.07
Diaromatics	7.50	7.50	0.31	0.00
PNA-s	5.06	5.06	0.20	0.07
Total N	950	146	1.0	1.0
Basic N	1	1	N.A.*	N.A.*
Total S	1200	1200	153.0	31.0
Densities @ 15C (g/cc)	.9295	.9295	.9717	.9510

INDIVIDUAL PRODUCT YIELDS, liq. vol% in the feed at 15C

	Feed	Ref Feed	PHENETHRIDINE (Ref Run)	DEN2 REF
Light Ends (Gas)*	-	-	0.8	1.8
135-195C Naph	-	-	10.7	10.6
195-290C Lt D	9.0	9.0	19.8	25.0
290-360C Hv D	10.8	10.8	11.7	11.1
360C+ Residue	59.0	59.4	42.2	37.1

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task T66-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: DPM-IN
Date of Report: 02-10-1988

INPUT DATA

RUN DESCRIPTION

EXP-7

Date of Commencing the Run: 18-08-1988
Feed: DIPHENYL-2-PYRIDYL METHANE DOPED DENE Sample No.: XE-7-DPM
Reference Feed: DENE
Comments: NONE

RUN CONDITIONS

Pressure, MPa (bar) 10.7 (1002.3)
Reactor Temperature, °C (°F) 180 (356)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, scc L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

DPM FEED DENE FEED
(Ref. ALF)

Feed Volume, cc (ambient)	128.00	128.00
Feed Density at 150	0.9095	0.9285
Feed Density, g/cc (ambient)	0.9274	0.9274
Total Liquid Product, g	117.73	117.73
TLF Density at 150	0.8643	0.8610
TLF Density, g/cc (ambient)	0.8600	0.8485
Stabilizer Gas Volume, L	122.90	122.90
Temperature, °C	14.0	14.0
Pressure, mm Hg	771	771

Stabilizer Gas Analyses, vol% at 150 and water-free basis

Hydrogen	89.37	89.37
Methane	0.15	0.12
Ethane	0.02	0.04
Propane	0.15	0.12
Isobutane	0.07	0.11
n-Butane	1.05	0.00
Isopentane	1.00	0.04
n-Pentane	1.00	0.10
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.04	0.11
Ammonia	0.00	0.00

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, 2

	Feed	Ref Feed	DPM FEED	DEN2 FEED (Ref Run)
IBP	236	236	236	236
10%	297	297	297	297
20%	326	326	326	326
30%	346	346	346	346
40%	367	367	367	367
50%	378	378	378	378
60%	398	398	398	398
70%	418	418	418	418
80%	442	442	442	442
90%	474	474	474	474
BBP	572	572	572	572

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DPM FEED	DEN2 FEED (Ref Run)
Monoaromatics	40.48	40.48	17.68	9.07
Diaromatics	7.50	7.50	0.04	0.00
PNA-s	8.04	8.04	0.17	0.07
Total N	472	446	1.0	1.0
Basic N	-	-	N.A.*	N.A.*
Total S	1200	1200	15.0	81.0
Densities @ 150° (g/cc)	.9285	.9285	.8448	.8510

Fraction Densities at 150° g/cc

	Feed	Ref Feed	DPM FEED	DEN2 FEED (Ref Run)
IBP-1950 Naph	-	-	0.7815	0.7815
195-2900 Lt D	0.8500	0.8500	0.8485	0.8485
290-3600 Hv D	0.8000	0.8000	0.8795	0.8795
3600+ Residue	0.9757	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of GC run

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task T66-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: DPM-IN
Date of Report: 02-10-1985

HYDROCRACKING REPORT

RUN DESCRIPTION

EXP-7

Date of Commencing the Run: 19-09-1985
Feed: DIPHENYL-2-PYRIDIL METHANE DOPED DEN2 Sample No.: MR-7-DPM
Reference Feed: DEN2
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.87
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	DPM FEED	DEN2 FEED (Ref Run)
Liquid Recovery, wt%	99.2	100.2
Liquid Recovery, vol%	107.0	109.6
Hydrocarbons in Ovhd Gas, wt%	0.2	0.2
Total Prod. Recovery, wt%	100.7	101.6
Total Prod. Recovery, vol%	108.2	111.2

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-7 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, 1

	Feed	Ref Feed	DRM FEED	DEND FEED (Ref Run)
1BP	188	188	66	74
10%	187	187	131	147
20%	183	183	167	182
30%	145	144	184	194
40%	127	127	110	117
50%	118	118	114	117
60%	168	168	154	140
70%	418	418	176	167
80%	418	442	402	391
90%	474	174	441	471
BBP	877	877	881	882

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	DRM FEED	DEND FEED (Ref Run)
Monoaromatics	40.48	40.48	17.48	9.07
Diaromatics	7.30	7.30	0.34	0.00
RNA's	8.01	8.01	0.17	0.07
Total N	471	246	1.0	1.0
Basic N	1	1	1.6.4	1.6.4
Total S	1200	1200	15.0	11.0
Densities @ 150 (g/cc)	.8188	.8188	.8697	.8811

INDIVIDUAL PRODUCT YIELDS, 114, 117 on the feed at 150

	Feed	Ref Feed	DRM FEED	DEND FEED (Ref Run)
Light Ends (Gas)*	-	-	10.1	4.8
155-195C Naph	-	-	11.7	10.8
195-290C Lt D	9.0	9.0	22.6	22.0
290-360C Hv D	10.8	10.8	11.1	11.1
360C+ Residue	59.0	59.4	38.7	41.1

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

ULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-94-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: TEMP. EFFECTS
 Date of Report: 1985-08-12

INPUT DATA

RUN DESCRIPTION:

Date of Commencing the Run: 1985-06-26
 Feed: DEN2 SYNCRUDE GAS OIL Sample No.: MR-2-EXP-B
 Reference Feed: DEN2 SYNCRUDE GAS OIL
 Comments: EFFECT OF REACTOR TEMP.

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
 Reactor Temperature, C (F) 0 (32)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.87
 Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	160C	370C	390C (Ref Run)
Feed Volume, cc (ambient)	126.50	126.00	139.00
Feed Density at 15C	0.9295	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236	0.9236
Total Liquid Product, g	116.16	115.42	127.77
TLP Density at 15C	0.8813	0.8761	0.8637
TLP Density, g/cc (ambient)	0.8765	0.8714	0.8586
Stabilizer Gas Volume, L	122.50	135.40	138.00
Temperature, C	25.0	24.5	24.5
Pressure, mm Hg	746	753	750

Stabilizer Gas Analyses, mole% on air- and water-free basis

	160C	370C	390C
Hydrogen	99.24	99.38	99.32
Methane	0.06	0.09	0.14
Ethane	0.00	0.18	0.00
Propane	0.11	0.02	0.15
Iso-Butane	0.08	0.00	0.08
n-Butane	0.00	0.11	0.00
Iso-Pentane	0.03	0.00	0.06
n-Pentane	0.00	0.00	0.00
Hexanes Plus	0.00	0.00	0.00
Hydrogen Sulfide	0.07	0.00	0.09
Ammonia	0.00	0.00	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	360C	370C	380C (Ref Run)
IBP	236	236	49	40	31
10%	297	297	201	182	154
20%	326	326	270	253	224
30%	346	346	302	290	270
40%	363	363	328	316	300
50%	379	379	350	339	326
60%	398	398	369	356	348
70%	418	418	391	381	372
80%	442	442	421	409	400
90%	474	474	458	446	439
FBP	573	573	565	539	534

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	360C	370C	380C (Ref Run)
Monoaromatics	40.48	40.48	26.72	23.75	17.83
Diaromatics	7.50	7.50	0.76	0.58	0.36
PNA-s	5.06	5.06	0.23	0.16	0.14
Total N	246	246	0.9	0.9	1.2
Basic N	1	1	N.A.*	N.A.*	N.A.*
Total S	1200	1200	39.6	20.5	6.3
Densities @ 15C (g/cc)	.9295	.9295	.8913	.8761	.8633

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	360C	380C (Ref Run)
IBP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.9500	0.8500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

N.A.=Not Available - expected to be below the detection limit of 30 ppm

GULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT

Hydrocracking Report Program

Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil

Input File No.: TEMP. EFFECTS

Date of Report: 1985-08-12

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-06-26

Feed: DEN2 SYNCRUDE GAS OIL Sample No.: MR-2-EXP-B

Reference Feed: DEN2 SYNCRUDE GAS OIL

Comments: EFFECT OF REACTOR TEMP.

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)

Reactor Temperature, C (F) 0 (32)

Feed Rate, cc/hr (ambient) 5.4

Catalyst Volume, cc 10.87

Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	360C	370C	380C (Ref Run)
Liquid Recovery, wt%	99.4	99.2	99.5
Liquid Recovery, vol%	104.8	105.1	107.1
Hydrocarbons in Ovhd Gas, wt%	0.5	0.7	0.8
Total Prod. Recovery, wt%*	100.1	99.9	100.4
Total Prod. Recovery, vol%*	105.8	106.3	108.6

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-8 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	360C	370C	380C (Ref Run)
IBP	236	236	49	40	31
10%	297	297	201	192	154
20%	326	326	270	257	224
30%	346	346	302	290	270
40%	367	367	328	316	300
50%	379	379	350	339	326
60%	398	398	369	356	348
70%	418	418	391	381	372
80%	442	442	421	409	400
90%	474	474	458	446	439
FBP	573	573	565	539	534

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	360C	370C	380C (Ref Run)
Monocaromatics	40.49	40.49	26.72	23.75	17.83
Diaromatics	7.50	7.50	0.76	0.58	0.36
PNA-s	5.06	5.06	0.23	0.16	0.14
Total N	246	246	0.9	0.9	1.2
Basic N	1	1	N.A.*	N.A.*	N.A.*
Total S	1200	1200	39.6	20.5	6.3
Densities @ 15C (g/cc)	.9295	.9295	.8917	.8761	.8633

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	360C	370C	380C (Ref Run)
Light Ends (Gas)*	-	-	0.9	1.2	1.4
IBP-195C Naph	-	-	11.3	13.1	19.1
195-290C Lt D	9.0	9.0	17.4	20.1	22.9
290-360C Hv D	30.8	30.8	30.4	33.1	30.1
360C+ Residue	59.0	59.4	45.9	38.9	36.1

Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

ULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 156-34-54: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Output File No.: IN-2-EXP-9
Date of Report: 1985-08-14

INPUT DATA

UN DESCRIPTION

Date of Commencing the Run: 1985-08-01
Feed: DEN2 SYNCRUDE GAS OIL Sample No.: MP-2-9
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: REACTOR TEMP. VARIED IN THIS EXP.

UN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 0 (32)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

	D-195	D-130	R-130 (Ref. Run)
Feed Volume, cc (ambient)	130.00	134.00	131.50
Feed Density at 15C	0.9295	0.9295	0.9344
Feed Density, g/cc (ambient)	0.9236	0.9236	0.9283
Total Liquid Product, g	119.27	123.65	121.06
TLP Density at 15C	0.9560	0.9208	0.9230
TLP Density, g/cc (ambient)	0.9514	0.9156	0.9182
Stabilizer Gas Volume, L	134.20	147.20	138.00
Temperature, C	24.5	25.5	25.5
Pressure, mm Hg	748	748	750

Stabilizer Gas Analyses, mole% on air- and water-free basis

	D-195	D-130	R-130
Hydrogen	88.25	88.01	88.87
Methane	0.18	0.00	0.00
Ethane	0.08	0.00	0.00
Propane	0.21	0.00	0.00
Iso-Butane	0.15	0.00	0.00
n-Butane	0.00	0.00	0.00
Iso-Pentane	0.03	0.00	0.00
n-Pentane	0.00	0.00	0.00
Hexanes Plus	0.00	0.00	0.00
Hydrogen Sulfide	0.07	0.02	0.00
Ammonia	0.00	0.00	0.00

EXP-8 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	D-385	D-330	R-330 (Ref Run)
1BP	205	236	20	195	160
10%	289	297	145	297	287
20%	321	326	209	325	317
30%	344	346	257	344	339
40%	362	367	290	361	357
50%	373	379	315	376	372
60%	396	398	341	397	389
70%	417	418	365	413	409
80%	441	442	392	437	437
90%	473	474	433	468	464
FBP	572	572	529	567	556

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	D-385	D-330	R-330 (Ref Run)
Monoaromatics	41.72	40.48	12.61	45.64	47.26
Diaromatics	9.60	7.50	0.24	3.39	3.94
PNA-s	6.22	5.06	0.07	1.70	2.38
Total N	963	246	1.0	91.0	111.0
Basic N	200	1	N.A.*	N.A.*	N.A.*
Total S	1500	1200	1.3	2404.0	2189.0
Densities @ 15C (g/cc)	.9295	.9344	.8560	.9208	.9230

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	D-385	R-330 (Ref Run)
1BP-195C Naph	-	-	0.7815	0.7815
195-290C Lt D	0.9500	0.9500	0.8485	0.8485
290-360C Hv D	0.9000	0.9000	0.8795	0.8795
360C+ Residue	0.9753	0.9679	0.8875	0.8875

* N.A.=Not Available - expected to be below the detection limit of 30 ppm

ULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: IN-2-EXP-8
Date of Report: 1985-08-14

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 1985-08-01
Feed: DEN2 SYNCRUDE GAS OIL Sample No.: MR-2-B
Reference Feed: DEN2 SYNCRUDE GAS OIL
Comments: REACTOR TEMP. VARIED IN THIS EXP.

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (3002.3)
Reactor Temperature, C (F) 0 (32)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	D-385	D-330	R-330 (Ref Run)
Liquid Recovery, wt%	99.2	99.9	99.2
Liquid Recovery, vol%	107.9	100.8	100.3
Hydrocarbons in Dvhd Gas, wt%	1.1	0.0	0.0
Total Prod. Recovery, wt%	100.6	99.9	99.2
Total Prod. Recovery, vol%	109.9	100.8	100.3

Includes hydrogen sulfide and ammonia in the overhead gas

EXP-8 Page 2

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	D-385	D-330	R-330 (Ref Run)
IBP	205	236	28	195	160
10%	289	297	145	297	287
20%	321	326	209	325	317
30%	344	346	257	344	339
40%	362	363	290	361	357
50%	378	379	315	375	372
60%	396	398	341	393	389
70%	417	418	365	413	409
80%	441	442	392	437	430
90%	473	474	433	468	464
FBP	572	573	529	567	556

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	D-385	D-330	R-330 (Ref Run)
Monoaromatics	41.72	40.48	12.51	45.64	47.26
Diaromatics	9.60	7.50	0.24	3.39	3.94
PNA-s	6.22	5.06	0.07	1.70	2.38
Total N	963	246	1.0	91.0	111.0
Basic N	200	1	N.A.*	N.A.*	N.A.*
Total S	1500	1200	1.3	%2404.0	%2189.0
Densities @ 15C (g/cc)	.9295	.9344	.9560	.9208	.9230

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	D-385	D-330	R-330 (Ref Run)
Light Ends (Gas)*	-	-	2.0	0.0	0.0
IBP-195C Naph	-	-	10.8	0.0	-0.7
195-290C Lt D	11.2	9.1	24.4	9.7	11.9
290-360C Hv D	29.5	31.0	29.3	31.4	31.3
360C+ Residue	58.3	59.7	37.4	60.8	57.9

Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 166-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: RESULFIDING
Date of Report: 12-10-85

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: 13-08-85
Feed: RAW SYNCRUDE GAS OIL Sample No.: MRL-S
Reference Feed: DEND SYNCRUDE GAS OIL
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 10.7 (3002.3)
Reactor Temperature, °C (°F) 790 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSES AND MISCELLANEOUS INPUT DATA

(Ref. Run)

Feed Volume, cc (ambient)	131.00	133.00
Feed Density at 150	0.9295	0.9295
Feed Density, g/cc (ambient)	0.9236	0.9236
Total Liquid Product, g	120.49	121.70
TLP Density at 150	0.9570	0.9561
TLP Density, g/cc (ambient)	0.9205	0.9214
Stabilizer Gas Volume, L	114.00	125.20
Temperature, °C	25.0	25.0
Pressure, mm Hg	760	760

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	95.31	95.15
Methane	0.25	0.17
Ethane	1.00	0.00
Propane	0.21	0.17
Iso-Butane	0.08	0.14
n-Butane	1.00	0.00
Iso-Pentane	0.07	0.04
n-Pentane	1.00	0.00
Hexanes Plus	0.00	0.00
Hydrogen Sulfide	0.07	0.08
Ammonia	0.00	0.00

EXP-8⁸⁶

FEED AND PRODUCT INSPECTION

Gas Chromatographic Distillation Results, 1

	Feed	Ref Feed	1	2
IBP	207	212	212	212
10%	139	137	138	130
20%	141	136	137	137
30%	144	146	138	144
40%	153	151	138	153
50%	158	148	145	157
60%	161	155	148	161
70%	171	163	151	164
80%	181	167	158	171
90%	197	174	170	180
BP	211	217	216	221

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm Wt%)

	Feed	Ref Feed	1	2
				(Ref Run)
Mononuclears	41.72	40.48	10.05	5.48
Diaromatics	2.50	7.50	0.08	0.03
PNA-s	5.22	5.05	0.12	0.06
Total N	49.44	53.03	1.0	1.0
Basic N	200	1	N.A.*	N.A.*
Total S	1500	100	273.0	5.2
Densities @ 157	.8298	.8298	.8570	.8761
(g/cc)				

Fraction Densities at 150.

	Feed	Ref Feed	1	2
				(Ref Run)
185-195C Neap	-	-	0.7815	0.7815
195-200C Lt 2	0.8500	0.8500	0.8485	0.8485
200-240C Hv 2	0.9000	0.9000	0.8765	0.8765
240C+ Residue	0.9751	0.9751	0.8815	0.8815

* N.A.=Not Available - expected to be below the detection limit of 10

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
 Hydrocracking Report Program
 Task 366-84-64: The Impact of Nitrogen Compounds on the
 Processing of Synthetic Gas Oil
 Input File No.: RESULFIDING
 Date of Report: 12-10-85

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: 15-02-85 **EXP-8**
 Feed: RAW SYNCRUDE GAS OIL Sample No.: MB2-S
 Reference Feed: DENS SYNCRUDE GAS OIL
 Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 10.7 (3002.3)
 Reactor Temperature, C (F) 390 (734)
 Feed Rate, cc/hr (ambient) 5.4
 Catalyst Volume, cc 10.7
 Hydrogen Flow Rate, std L gas per L feed 1000

OVERALL YIELDS

	7	2 (Ref Run)
Liquid Recovery, wt%	99.6	99.1
Liquid Recovery, vol%	127.7	110.1
Hydrocarbons in Ovhd Gas, wt%	0.6	0.6
Total Prod. Recovery, wt%*	100.6	100.1
Total Prod. Recovery, vol%*	128.7	111.7

*Includes hydrogen sulfide and ammonia in the overhead gas

EXP-8 Page 1

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, 1

	Feed	Ref Feed	7	8 (Ref Run)
IBP	120.8	121.5	120.8	121.5
10%	139.9	139.7	139.9	139.7
20%	150.1	150.2	150.1	150.2
30%	158.4	158.6	158.4	158.6
40%	164.1	164.1	164.1	164.1
50%	172.3	172.3	172.3	172.3
60%	178.6	178.6	178.6	178.6
70%	187.7	187.7	187.7	187.7
80%	194.1	194.1	194.1	194.1
90%	197.1	197.1	197.1	197.1
BBP	207.1	207.1	207.1	207.1

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	7	8 (Ref Run)
Monocaromatics	41.72	40.48	10.08	5.48
Diaromatics	3.60	7.50	0.08	0.07
PN4-s	6.22	3.06	0.12	0.05
Total N	257	246	1.0	1.0
Basic N	200	1	N.A.*	N.A.*
Total S	1500	1200	237.0	5.9
Densities @ 15C (g/cc)	.9295	.9295	.8570	.8761

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 15C

	Feed	Ref Feed	7	8 (Ref Run)
Light Ends (Gas)*	-	-	1.0	1.0
IBP-195C Naph	-	-	10.0	10.0
195-290C Lt D	11.2	9.0	25.6	25.0
290-360C Hv D	19.5	10.8	10.0	16.0
360C+ Residue	58.7	59.4	22.1	28.0

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

SULF CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 166-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: CAT DENG FEED
Date of Report:

INPUT DATA

RUN DESCRIPTION

Date of Commencing the Run: **EXP-8**
Feed: CAT. DENG FEED (EFFLUENT) Sample No.: MRC-CAT
Reference Feed: 1100 CAT DENG FEED
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 10.7 (1552.7)
Reactor Temperature, °C (°F) 390 (734)
Feed Rate, cc/hr (ambient) 5.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, std L gas per L feed 1000

STABILIZER GAS ANALYSIS AND SCCELLANEOUS INPUT DATA

(Ref Run)

Feed Volume, cc (ambient) 83.00
Feed Density at 150 0.8206
Feed Density, g/cc (ambient) 0.8147
Total Liquid Product, g 83.18
TLR Density at 150 0.8145
TLR Density, g/cc (ambient) 0.7460
Stabilizer Gas Volume, L 107.00
Temperature, °C 25.0
Pressure, mm Hg 751

Stabilizer Gas Analyses, mole% on air- and water-free basis

Hydrogen	66.48
Methane	3.14
Ethane	0.00
Propane	3.19
Isobutane	0.12
n-Butane	3.00
Isopentane	0.00
n-Pentane	3.00
Hexanes Plus	0.00
Hydrogen Sulfide	3.00
Ammonia	0.00

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, C

	Feed	Ref Feed	Ref Run
IBP	134	134	134
10%	135	137	137
20%	144	145	147
30%	150	145	144
40%	155	147	151
50%	171	155	151
60%	188	168	166
70%	193	173	173
80%	471	441	444
90%	462	174	404
BBP	541	577	515

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm)

	Feed	Ref Feed	Ref Run
Monoaromatics	44.77	40.45	4.5c
Diaromatics	2.78	1.50	0.09
PNA's	2.16	3.06	0.00
Total N	50	44	1.0
Basic N	28	-	N.A.*
Total S	1750	1200	53.4
Densities @ 15C (g/cc)	.9206	.9285	.9145

Fraction Densities at 15C, g/cc

	Feed	Ref Feed	Ref Run
185-195C Naph	-	-	0.7915
195-240C Lt D	0.8500	0.8500	0.8485
240-340C Hv D	0.9000	0.9000	0.8795
340C+ Residue	0.9753	0.8678	0.8873

* N.A.=Not Available - expected to be below the detection limit of 1%

311F CANADA RESEARCH AND DEVELOPMENT DEPARTMENT
Hydrocracking Report Program
Task 366-84-64: The Impact of Nitrogen Compounds on the
Processing of Synthetic Gas Oil
Input File No.: CAT DEN2 FEED
Date of Report:

HYDROCRACKING REPORT

RUN DESCRIPTION

Date of Commencing the Run: **EXP-8**
Feed: CAT. DEN2 FEED (EFFLUENT) Sample No.: MR2-CAT
Reference Feed: T100 CAT DEN2 FEED
Comments: NONE

RUN CONDITIONS

Pressure, MPa (psi) 20.7 (T002.3)
Reactor Temperature, C (F) 390 (734)
Feed Rate, cc/hr (ambient) 3.4
Catalyst Volume, cc 10.7
Hydrogen Flow Rate, and L gas per L feed 1000

OVERALL YIELDS

-
-
(Ref Run)

Liquid Recovery, wt%	108.8
Liquid Recovery, vol%	114.7
Hydrocarbons in Over Gas, wt%	0.0
Total Prod. Recovery, wt%	109.4
Total Prod. Recovery, vol%	115.8

*Includes hydrogen sulfide and ammonia in the overhead gas

FEED AND PRODUCT INSPECTIONS

Gas Chromatographic Distillation Results, D

	Feed	Ref Feed	T (Ref Run)
IBP	186	176	20
10%	195	187	122
20%	216	212	177
30%	223	246	214
40%	232	267	251
50%	271	273	281
60%	289	288	308
70%	408	413	338
80%	472	442	364
90%	462	474	404
FBP	541	577	518

Mole% Aromatics from UV Spectroscopy, N and S Contents (ppm w/w)

	Feed	Ref Feed	T (Ref Run)
Monoaromatics	44.77	40.48	4.56
Diaromatics	2.72	7.50	0.09
PNA-s	2.18	5.06	0.00
Total N	160	146	1.0
Basic N	88	-	N.A.*
Total S	1350	1200	58.4
Densities @ 150 (g/cc)	.9295	.9295	.9245

INDIVIDUAL PRODUCT YIELDS, liq. vol% on the feed at 150

	Feed	Ref Feed	T (Ref Run)
Light Ends (Gas)*	-	-	1.2
IBP-195C Naph	-	-	13.4
195-270C Lt D	12.4	8.0	34.2
270-360C Hv D	12.8	10.3	29.3
360C+ Residue	54.2	59.4	24.8

* Hydrocarbons only, i.e. hydrogen sulfide and ammonia are not included

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